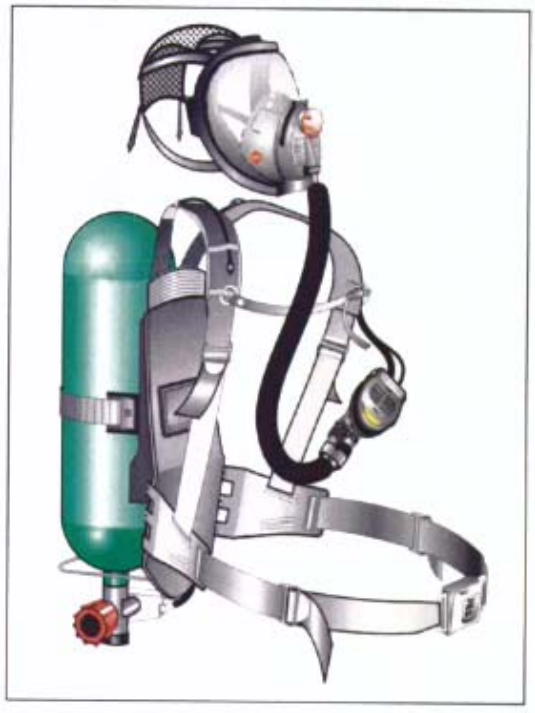
D R A F T F OR EXTERNAL REVIEW
September 12, 2005

CBRN SCBA User's Guide:

Technical Use of
Open Circuit, Pressure-Demand, Self-Contained Breathing Apparatus (SCBA) Respirator with Chemical, Biological, Radiological, Nuclear (CBRN) Protection Certified Under Title 42, Code of Federal Regulations, Part 84

(OD Review # 04031)



United States Department of Health and Human Services
Centers for Disease Control and Prevention and Agency for Toxic Substances and Disease Registry
National Institute for Occupational Safety and Health
National Personal Protective Equipment Technology Laboratory

DISCLAIMER

The mention of any company, end user, product or policy, and the inclusion of any reference to such do not constitute endorsement by the NIOSH or the NPPTL. This guide is based on presently available technical information and best practices. It is not citable for private sector, commercial advertisement purposes. United States federal government agencies can freely reference this guide in support of collaborative scientific and practical use projects and NIOSH respirator approval holders can continue to advertise respirator compliance to appropriate NIOSH standards. The recommendations discussed in this guide may require modification when additional and relevant information becomes available or when additional NIOSH publications are updated or promulgated.

Front cover: CBRN SCBA drawings showing a mask mounted regulator version on the left and an air hatch version on the right. NIOSH/NPPTL, Mr. Marion Molchen, KI, LLC., August, 2005.

ORDERING INFORMATION:

To receive documents or more information concerning occupational safety and health topics in the area of chemical, biological, radiological, nuclear respiratory protection, contact the NIOSH at

Publications Dissemination
4676 Columbia Parkway
Cincinnati, OH 45226-1998
Telephone: 1-800-35-NIOSH (1-800-356-4674)
Fax: 1-513-533-8573
Email: **pubstaff@cdc.gov**

Visit the NIOSH web sites at **www.cdc.gov/niosh**
or **www.cdc.gov/niosh/npptl/default/html**

Figure1: Chemical warfare kit and hydration device on open-circuit, pressure demand, SCBA, NIOSH Survey, October 19, 2001.

FOREWORD

The CBRN SCBA User's Guide focuses on the open circuit, pressure-demand, self-contained breathing apparatus respirator, commonly known as a SCBA. The purpose is to assist individual emergency responders, SCBA maintenance technicians, supervisors and respirator protection program managers in developing CBRN SCBA selection logic and use guidelines. The guide outlines key points that show a responder how to recognize new or used NIOSH-approved CBRN SCBA and what the limitations are of the CBRN SCBA, while at the same time, it provides best practice use guidelines regarding what to do before, during, or after a CBRN terrorist incident.

The workplace, especially for emergency responders in the United States, is dangerous. Public health hazards from natural disasters, terrorism incidents or industrial accidents continue to pose unique situational challenges. Recent current events have contributed to defining additional workplace hazards as a result of civilian evacuation, sheltering, and recovery responses.

The occupational safety and health measures that are vital in protecting responders and other workers continue to evolve. Workplace safety and health measures are defined for certain public health emergencies, and, in other cases, are being updated for anticipated emergencies involving chemical, biological, radiological or nuclear weapons effects or known catastrophic effects from natural disasters. As new scientific methods related to mitigating public health emergencies emerge from lessons learned during natural disaster responses, terrorism incident management exercises, emergency responder preparedness observations, and life-saving responses - current workplace conditions are expected to become safer through the use of better predictive software, mechanical engineering controls, personal protective equipment and administrative safety programs.

NIOSH realizes the dynamics of the evolving workplace and has been documenting, evaluating, and creating new personal protective equipment assessments and respirator certification standards in support of other joint federal and stakeholder efforts focused on incidents of national significance and the changing dynamics of occupational safety and health. In concert with the U.S Occupational Safety and Health Administration, NIOSH continues to evaluate, describe and recommend workplace safety measures and actions for all hazards.

This CBRN SCBA user's guide is the foundation for a comprehensive NIOSH special hazard family of CBRN respirator use guides. The guides are based on three primary sources of input: First, the technical requirements defined in a NIOSH policy letter to all respirator manufacturers, dated December 28, 2001; second, the NIOSH statement of standard and standard test procedures for that policy letter; and third, best practices summarized from a multitude of internal NIOSH reviewers, public comments and external peer reviews. It is with great honor that I offer this CBRN SCBA user's guide to the emergency responders of the United States of America.

Director's Signature:
National Institute for Occupational Safety and Health

ACKNOWLEDGMENTS

(To Be Published)

Table of Contents

Foreword 3
Acronyms 6-8

CHAPTER 1: SCBA Design Requirements 9

CHAPTER 2: NIOSH Certification Factors.....xxx

CHAPTER 3: Production Model Safety Markings xxx

CHAPTER 4: CBRN Respirator Use Life (CRUL) xxx

CHAPTER 5: Before, During and After Use Actions.....xxx

CHAPTER 6: Integration SCBA with Protective Suits.....xxx

CHAPTER 7: Projected User Needs xxx

Appendix A, Definitions
Appendix B, SCBA components
Appendix C, CBRN respirator guidelines cycle
Appendix D, Frequently asked questions
Appendix E, Sample NIOSH approval label
Appendix F, User's guidance checklist
Appendix G, CBRN SCBA training aid-placeholder
Appendix H, Survey of SCBA: LAT observations
Appendix I, References cited and bibliography

ACRONYMS

AEGL - acute exposure guideline(s) (AEGL 1, AEGL 2, AEGL 3)
APF - assigned protection factor
APR - air-purifying respirator

BA - breathing apparatus
BWA - biological warfare agent
B-NICE - biological, nuclear, incendiary, chemical, or explosive

CASARM – chemical agent standard analytical reference material (program/grade of agent)
CBR - Chemical, Biological, or Radiological
CBRE - Chemical, Biological, Radiological or Explosive
CBRN - Chemical, Biological, Radiological, and Nuclear or Chemical, Biological, Radiological, Nuclear
CBRNE - Chemical, Biological, Radiological, Nuclear, and Explosive
CEL – certified equipment list (NIOSH)
CDC - Centers for Disease Control and Prevention
CFR - Code of Federal Regulations
CGA - Compressed Gas Association
CRUL - CBRN Respirator Use Life
CWA - chemical warfare agent(s)

DoD/DOD – U.S. Department of Defense
DOJ – U.S. Department of Justice
DHS – U.S. Department of Homeland Security
DOT – U.S. Department of Transportation

ECBC - Edgewood Chemical Biological Center, US Army
EOD - Explosive Ordnance Disposal
EOSTI - end-of-service-time indicator
EPA – U.S. Environmental Protection Agency
ESCBA - industrial escape SCBA
ESLI - End-of-Service-Life Indicator (NIOSH)

FFPE - firefighter protective ensemble, also known as bunker gear or turnout gear

GB – "Sarin Nerve Gas": G-series nerve chemical warfare agent

HAZMAT - hazardous material
HAZWOPER - Hazardous Waste Operations and Emergency Response
HD – "Mustard Gas": H-series, sulfur mustard blister agent distilled by washing and vacuum distillation
HHS – U.S. Department of Health and Human Services
HUD - heads-up display

IAB - Inter-Agency Board for Equipment Standardization and Interoperability Working Group
IDLH - immediately dangerous to life and health (See NIOSH Emergency Response Cards)
IED - improvised explosive device
IND - improvised nuclear device
ISEA - International Safety Equipment Association
ISO – International Standards Organization

LANL - Los Alamos National Laboratory, U.S. Department of Energy, University of California
LAT - live agent test/CASARM Neat Live Agent Test
LED - light emitting diode
LEL – lower explosive limit
LRPL - laboratory respirator protection level

MUC - maximum use concentration

NBC - Nuclear, Biological and Chemical
NFPA - National Fire Protection Association
NIOSH- The National Institute for Occupational Safety and Health
NIST - National Institute of Standards and Technology, U.S. Department of Commerce
NPPTL - National Personal Protective Technology Laboratory (NIOSH)

OEL – occupational exposure limit (NIOSH)
OSHA - Occupational Safety and Health Administration (DOL)

PAPR - powered air-purifying respirator
PASS - personal alert safety system
PBZ – personal breathing zone
PEL - permissible exposure limit (OSHA)
PPE - personal protective equipment
ppm – parts per million
PSIG - pounds force of pressure per square inch gauge (excluding atmospheric pressure)

QLFT - qualitative fit test (for a respirator)
QNFT - quantitative fit test (for a respirator)

RDECOM - Research, Development and Engineering Command, US Army, formerly SBCCOM
REL - recommended exposure limit (NIOSH)
RIC/UAC - Rapid intervention crew (company)/universal air connection system
RIT - Rapid intervention team
RKB - Responder knowledge base (IAB)
RPD – respirator protective device
RSL – respirator selection logic (formerly respirator decision logic/RDL)

SAR – supplied-air respirator
SBCCOM - Soldier, Biological, and Chemical Command, US Army (replaced by RDECOM name)

SCBA - self-contained breathing apparatus (singular)
SCER - self-contained escape respirator (CBRN)
SEI - Safety Equipment Institute, private, non-profit third party certification organization
SLUDGE - salivation, lacrimation, urination, defecation, gastro-intestinal distress and emesis
SMARTMAN - SiMulant Agent Resistant Test MANikin
SOP – standard operating procedure(s)
STEL – short-term exposure limit
STP – standard test procedure(s)
SWAT - special weapons and tactics

TBD – to be determined
TIC - toxic industrial chemical(s)
TIM - toxic industrial material(s)
TRA – test representative agent(s)
TWA – time-weighted average

USAR – urban search and rescue
UI - User's Instruction(s)

VX – "VX Nerve Gas": V-series nerve, chemical warfare agent

WMD - weapon(s) of mass destruction

Note: *The acronyms are expected to be commonly used in CBRN incident response. The list is not designed to be all encompassing. All or some of the acronyms have the potential for use during CBRN incidents or other incidents of catastrophic magnitude. Lead federal agency policies and guidance in effect at the time of incident response and recovery have precedence.*

Figure 2: Candidate SCBA for NIOSH CBRN protection mounted on SMARTMAN Headform, NIOSH and RDECOM, 2004.

Chapter 1: SCBA DESIGN REQUIREMENTS

BACKGROUND AND PURPOSE

The purpose of the guide is threefold. First, the guide is intended to assist individual respirator wearers, tactical leaders, deployed squads, emergency response teams, respirator program administrators and supervisors in recognizing NIOSH-approved CBRN SCBA from traditional NFPA- compliant SCBA or NIOSH-approved industrial SCBA. Second, the guide is intended to educate users on the applicable cautions and limitations of a CBRN SCBA so they know, upfront that the CBRN SCBA will not be the all encompassing "magic bullet" to a CBRN response. And third it will provide use recommendations in the form of cumulative best practices most likely to contribute to life-saving actions before, during, and after a CBRN incident response. This user's guide is intended to be updated as information is gained from relevant current events and as technology advances and additional standards are developed.

The guide provides recommended actions for clearly identifying newly purchased CBRN SCBA, inspecting field deployed SCBA upgraded to CBRN protection (retrofitted) and developing use life criteria for contaminated CBRN SCBA. It also provides recommendations for assessing SCBA for NIOSH CBRN compliance, distinguishing between NIOSH CBRN approved SCBA and NIOSH industrial approved SCBA or NFPA compliant SCBA, preparing respirators for CBRN response, using respirators in potential or known CBRN incidents and discarding contaminated respirators in post-incident responses. It offers practical guidance for the proper use of specific types of NIOSH-approved SCBA, which have passed NIOSH special CBRN requirements tests.

Select or all portions of the guide are useful for respirator protection program administrators; however, most of the information is focused on how to assist emergency responders in identifying, maintaining, using and integrating CBRN SCBA. In the course of assisting responders in those tasks, standardization of terms will likely occur and contribute to more efficient emergency operations center functions and ease of mission support. One example of multiple terms for the same type of equipment is the fact that some responders use the name "SCBA" for the open-circuit SCBA, while others use "BA", or "Air Paks" when referring to SCBA.

NOTE: Attention all emergency responders or other trained users: The sole use of a CBRN SCBA will not protect you from the effects of all or some CBRN agents. CBRN SCBA must be used in conjunction with appropriate full body skin protection. Expedient coverage of all exposed skin will help reduce the amount of agent a first responder is exposed to and ultimately the severity of potentially debilitating acute or chronic effects. Proper use of a respirator is a complex process requiring the knowledge of proper selection and fit for a specific contaminant or environment and awareness of respirator use limitations.

While the intent of NIOSH is to integrate a respirator seamlessly into the responder's personal protection equipment (PPE), conscious effort must be made by the user to obtain the maximum level of protection afforded by the respirator and its interface with individual PPE.

The information in this guide is intended to be administered through a complete respiratory protection program under the Occupational Safety and Health Administration (OSHA) Respiratory Protection Standard and relies on the user being properly trained and proficient [29 CFR 1910.134]. When a respiratory protection program is not in place, this guide can serve as a reference for the safe operation of a CBRN SCBA.

The respirator protection program includes the following criteria for selecting respirators: medical evaluations, fit testing, use, maintenance, inspection, breathing air quality, cleaning, storage, worker training, program logistics, and regular evaluations of program effectiveness. The respiratory protection program is directed by a designated knowledgeable professional (competent person) known in OSHA language as the respirator program administrator. The respirator program administrator oversees all aspects of the respirator program, interacts with management personnel and is available to the user as a resource for questions or concerns on respirator use. How a respirator program administrator integrates recommendations concerning CBRN SCBA use is contingent on adapting available respirator selection logic with situational analysis at the time of use.

The CBRN SCBA user's guide is subject to continual review and update as facts and best practices change due to technology evolutions, standards development or changes in incident response protocol due to world event aftermaths and characterization. While the guide is intended for respirator users, as stated, it contains elements that are ideally suited for consideration by respirator protection program administrators, supervisors and incident commanders.

Information on the OSHA Respiratory Protection Standard [29 CFR 1910.134] is available at: http://www.osha.gov/SLTC/etools/respiratory/index.html

RATIONALE: INTERAGENCY BOARD (IAB) and INTER-AGENCY AGREEMENTS (IAA)

IAB. In October 1998, the Attorney General of the United States and the Department of Defense's Director of Military Support commissioned a first responder "interagency board". Its mission was to develop methods that ensure personal protective equipment standardization and interoperability, to encourage the research and development of advanced technologies, and to assist first responders at the state and local levels in establishing and maintaining a robust crisis and consequence management capability [IAB 1999].

The board, which became known formally as the InterAgency Board for Equipment Standardization and InterOperability Working Group (IAB), was supported by voluntary participation of various local, state and federal government and private organizations. The IAB mission at that time was to establish and coordinate local, state and federal standardization, interoperability, and responder safety, and to mitigate and recover from any incident by identifying requirements for chemical, biological, radiological, nuclear or explosives (CBRNE) incident response equipment [IAB 1999].

The IAB accomplishes its mission statement by using committee consensus results and subgroup analysis techniques to generate generic equipment and CBRNE reference lists in twelve sections: PPE, explosive

device mitigation and remediation equipment, CBRNE operational and search and rescue equipment, information technology, cyber-security enhancement equipment, interoperable communications equipment, detection, decontamination, medical, power (electrical), CBRNE reference materials and CBRNE standards [IAB 1999].

In 1999, the IAB initiated a request for the development of federal standards and guidelines for personnel protective equipment, with respiratory protection equipment as one of the top priorities. In response to this 1999 initiative, the National Institute for Standards and Technology (NIST), NFPA, NIOSH and OSHA entered into a memorandum of understanding that defines each agency's role in developing, establishing, and enforcing standards or publishing guidelines for responders' respiratory protective devices.

Since the inception of the IAB, annual reports and standardized equipment lists have been published. The most recent report refines what the IAB is and its mission statement. Go tohttp://www.iab.gov/

IAA. Subsequently, in 2001, the Centers for Disease Control and Prevention (CDC) and NIOSH entered into an Inter-agency Agreement number 02-03 (IAA 02-03) with the United States Army, Soldier, Biological Chemical Command (SBCCOM/RDECOM) titled *Testing Activities to Support Respirator Standards Development and Approval Testing*, which allowed multiple federal agreements. NIOSH plans to collaborate with RDECOM on the establishment of test procedures for various classes of respirators for use by first responders to incidents of terrorism, provide RDECOM standard test procedures, and reimburse RDECOM for costs of conducting NIOSH laboratory tests. In return, RDECOM provides laboratory testing and administrative services for performance of NIOSH standard test procedures requested by NIOSH/NPPTL. RDECOM assures that its laboratory practices are documented and followed, provides NIOSH with test reports for all required tests, and collaborates with NIOSH on the establishment of new test procedures for various classes of respirators used by first responders to incidents of terrorism [CDC 2001]. The collaborative standards development and research efforts of IAA 02-03 resulted in the first NIOSH CBRN SCBA certification standard, dated December 28, 2001, the ongoing CBRN SCBA certification program and CBRN SCBA upgrade kit certification program. Information related to the CBRN SCBA standard and CBRN SCBA upgrade/retrofit kit letter is located at the following websites: http://www.cdc.gov/niosh/npptl/standardsdev/cbrn/scba/ http://www.cdc.gov/niosh/npptl/resources/pressrel/letters/lttr-031103c.html

RATIONALE: SCBA STANDARD DEVELOPMENT AND HAZARD ANALYSIS

The NIOSH National Personal Protective Technology Laboratory leads the development of a CBRN respirator certification program that bolsters U.S. emergency responder preparedness. Working with diverse business and federal partners, NPPTL expedited development of stringent new testing and certification respirator standards for voluntary use by emergency responders in training and during terrorist attacks. NPPTL established this new program to meet the perceived, understood and emerging needs of all U.S. emergency responders after the events of September 11, 2001.

To determine the testing and certification requirements for the CBRN SCBA, the following areas were defined, reviewed and acted on:

- Initially, a market survey of current SCBA technology was conducted by NIOSH, with the support of the International Safety Equipment Association (ISEA), in October, 2001. The survey resulted in the NIOSH benchmark testing available industrial, NIOSH-approved and NFPA-compliant SCBA using existing U.S. Army Soldier, Biological and Chemical Command (SBCCOM), Edgewood Chemical Biological Center (ECBC), chemical warfare agent test methods adapted and upgraded by NIOSH for bench mark survey purposes

- In parallel, a NIOSH policy review determined the applicability of current 42 CFR Part 84 standards and NIOSH authority to implement new CBRN SCBA certification testing by policy, as opposed to formal rule-making (due diligence for legal and congressional review)

- Lastly, a hazard analysis of possible CWA incidents and physical hazards was defined by the U.S Army RDECOM and adopted with comment by NIOSH/NPPTL. Because gas and vapors are more permeable than radiological and biological particles, the focus of SCBA CBRN testing was on chemical warfare agent vapor and liquid penetration and permeation effects.

- Subsequently, a corresponding analysis of human factor and CBRN special test protection requirements were written, developed, verified and validated under the IAA and new NIOSH CBRN standard test procedures were published.

Tables 1 and 2 below are samples of generic graphs of test results produced from the NIOSH-SBCCOM SCBA benchmark survey testing. A discussion regarding the test results was conducted with respirator manufacturers in 2001. NIOSH provided each respirator manufacturer that attended the discussion with their own proprietary binder of the test results specific to their SCBA. Table 1 shows the NIOSH GB nose-cup data generated by the RDECOM test methods available at that time for live agent testing of nine off-the-shelf SCBA. Table 2 indicates similar data but is HD nose-cup data. NIOSH observations of the live agent test benchmark survey experiments on off-the-shelf SCBA are provided in Appendix H, LAT SCBA Survey.

This data and numerous other observations are experimental results and served to provide bench mark reference and standard test procedure foundations for NIOSH CBRN SCBA standards development. They were not intended to be used as final interpretations of SCBA performance but simply as assessments of the test methodologies available to generate CASARM program neat agent concentrations using available civilian respirators and select accessories. Observations such as outright catastrophic destruction of SCBA second stage regulators due to liquid/aerosol HD permeation of air pressure boundaries and ease of GB penetrating breathing zone areas of those same types of SCBA provided NIOSH with minimal bench test evidence and rationale sufficient enough to commence official formal development of CBRN SCBA standards. The new NIOSH respirator standard increased the protective capabilities of available SCBA against chemical warfare agents and particulates.

Table 1: Extract of GB agent data, time versus concentration, 480 minutes, October 2001-NIOSH CBRN bench mark survey experimental data for 9 SCBA.

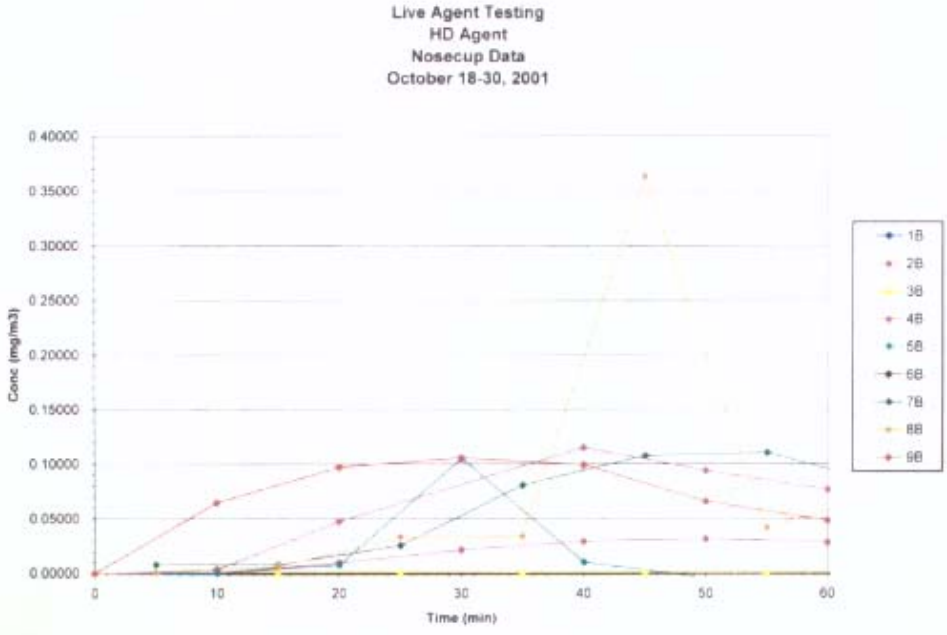


Table 2: Extract of HD Agent Data, Time versus Concentration, 60 minutes, October 18-30, 2001- NIOSH bench mark survey experimental data for 9 SCBA.

A joint NIOSH/NPPTL and RDECOM CBRN hazard assessment considered the physical/chemical characteristics of agents and the use of potential terrorist target modeling techniques to generate contamination concentration profiles for the potential hazards of an incident involving CWA. For these assessments, the means of delivery and dissemination of the CWA were considered, combined with other

variables including the amount of CWA employed, and the environmental and physical characteristics of the area where the incident may occur. This threat analysis and the inclusion of toxicological acute exposure guideline level (AEGL) values were incorporated into test requirements, as well as resultant pass/fail values and requirements of the CBRN SCBA standard test procedures.

By combining the threat analysis with the policy definitions of 42 CFR, Part 84 sub-paragraphs and the fire safety compliance inspections of the NFPA contracted testing laboratories, NIOSH generated a CBRN SCBA certification standard that revolutionized the SCBA manufacturing industry and demonstrated a higher standard of protection. A CBRN SCBA has a triple level of approval review consisting of 42 CFR Part 84 13F respirator class requirements, NFPA 1981 standard compliance and NIOSH special CBRN tests. The result is a respiratory protective device that provides a higher degree of inhalation protection against multitple hazards/all hazards while adapting to currently available technology. The adoption of the triple level of approval became known in NIOSH language as the "Three-Tier Approval Process."

Three-Tier Approval Process

NIOSH established the three-tier approval program, which enhances performance and design requirements for certification, to meet identified respiratory protection needs, environmental use conditions of emergency responders, and predicted emergency responder attack hazard exposures based on a variety of exposure scenarios ranging from open air to confined space venues. The worst case scenario was determined to be a confined space with the possibility of concentrated chemical warfare compounds, lower explosive limits (LEL), varying oxygen levels, or displaced oxygen concentrations.

- **Tier 1** — Tier 1 is the NIOSH industrial compliant certification. The first tier ensures the CBRN SCBA meets existing NIOSH industrial 13F minimum SCBA performance requirements to Subpart H of 42 CFR Part 84. The SCBA CBRN certification program utilizes the vast amount of experience NIOSH has in approving industrial technical certification number (TC-) 13F approvals in the occupational workplace under NIOSH 42 CFR84, subpart H, as well as subpart L. The CBRN SCBA candidate is required to obtain Part 84 13F approval prior to being submitted for NIOSH CBRN protection testing. Part 84 compliance reviews by NIOSH is conducted in the initial review of the new extension application for CBRN SCBA approval.

- **Tier 2** — Tier 2 is the NFPA compliance certification. The second tier is done by an independent, third party accredited certification organization to *NFPA 1981, Standard on Open-Circuit Self-Contained Breathing Apparatus for Fire and Emergency Services, current edition,* requirements. *NFPA 1981* contains critical SCBA performance requirements unique to firefighting and operations in hazardous environments [NFPA 1981, edition 2002, effective August 8, 2002, or equivalent]. As the consensus standard for SCBA equipment used by the U.S. Fire Service, compliance with *NFPA 1981* ensures the CBRN SCBA can withstand routine structural fire hazard exposure —a protective quality deemed necessary in responding to any explosive terrorist device incident. NFPA compliance testing for the program incorporates the enhanced performance requirements of the *NFPA 1981* standard including higher minimum flow rates and improved breathing resistance. *NFPA 1981* testing simulates SCBA use conditions through environmental exposures including high and low temperature conditions, heat and flame exposure, accelerated corrosion, particulate exposure, and vibration. Lens abrasion and communications (i.e., speech intelligibility while wearing the SCBA) also are evaluated. These critical

systems tests show how the NIOSH CBRN SCBA approval is interwoven with existing standard setting organizations and utilizes the best of available technology to provide a higher level of combined protection.

- **Tier 3** — Tier 3 is the NIOSH special CBRN test requirements. It consists of three CBRN special tests:
  - 1) Sarin/GB Live Agent Test (LAT)
  - 2) Distilled Sulfur Mustard/HD LAT
  - 3) Corn Oil-Laboratory Respirator Protection Level Test/ corn oil LRPL.

    - Live agent tests measure CWA permeation and penetration resistance against Sarin vapor (GB) and sulfur mustard (HD) liquid and aerosol. These compounds are actual chemical warfare agents of neat grade in a CASARM program. They are commonly known as "live agent(s)", as opposed to simulated agent or training agents, and they are used to gain assessment of the respirator's protective qualities against the unique penetration properties of GB liquid aerosol and the caustic permeation properties of HD liquid aerosol and HD liquid droplets.

    - GB and HD LAT involve contaminating the entire SCBA, minus cylinder, to chemical warfare agents while mounted on a metal headform. Live agent testing uses a pre-screening process on the SCBA by first exposing the respirator to an instrument called a TDA-99M particulate generator. LAT generally require two phases of deliberate testing: the pre-screening particulate assessment and the chemical warfare agent contamination test. In the pre-screening particulate assessment a calibrated instrument called a TDA-99M uses non-toxic oil aerosol to check for gross air pressure boundary leaks both before and after the live agent test is conducted. Following the initial "before" test pre-screening, a SiMulant Agent Resistant Test Manikin (SMARTMAN) head form is used to replicate a consistent headform shape to mount the respirator on. The entire respirator system is placed in the live agent test chamber. While in the live agent test chamber, another TDA-99M procedure is done to verify sealing and confirm that air pressure boundaries are intact prior to agent release and contamination of the respirator. The CWA Sarin (GB) and Distilled Sulfur Mustard (HD) are then used to evaluate the CBRN SCBA protection of the breathing zone of a static manikin head form while the respirator breathes at a cyclic rate for six continuous hours. The resultant resistance of the SCBA systems and accessories to agent penetration and permeation is detected by dual redundant instruments under controlled A2L2 International Standards Organization (ISO) compliant laboratory conditions.

    - The laboratory respirator protection level (LRPL) test helps NIOSH and NPPTL to determine the degree of fit a given respirator faceblank allows and whether or not that faceblank and the size range marketed by the manufacturer, can fit a wide range of facial sizes based on the accepted Los Alamos National Laboratory (LANL) distribution of face sizes panel. Essentially, the LRPL test trials ensure that the facepiece seal of the personal breathing zone (PBZ)- the interface between the user and the SCBA facepiece- quantitatively demonstrates an acceptable fit factor ratio of greater than 500 on a panel of human test subjects. The human test subjects are safely processed per a human subject

review board (HSRB) protocol and the test subject panel is intended to approximate 95% of the facial sizes of a given user population.

- LRPL test is a protection factor test involving independent human test subjects self-donning adapted SCBA facepieces and maintaining an acceptable laboratory protection level against corn oil particulates. A NIOSH and RDECOM human subject review board (HSRB) approves the use of federal employees as human test subjects contaminated/exposed to corn-oil (cooking oil). See NIOSH and RDECOM HSRB protocol number HSRB-02-NPPTL-06XP, dated per controlled correspondence requirements. Once all the LAT are complete, a NIOSH/NPPTL laboratory respirator protection level (LRPL) test is conducted based on the number of specified sizes of facepieces envisioned by the respirator manufacturer. LRPL corn-oil testing utilizes 11 specific user tasks that each human subject must perform successfully while wearing and maintaining a seal. LRPL test trials (2 trials per test subject) evaluate the performance of the identical tested facepiece with only its mounted accessories and not the entire SCBA. This LRPL test is done using quantitative fit test measurements per standards published by the U.S. Occupational Safety and Health Act (OSHA). While a series of separate facepiece types are not available to the human test subject as they would be in workplace OSHA fit testing, the LRPL tested facepiece and all its sizes are adapted by using a manufacturer specific negative pressure adapter and particulate filtration media per the OSHA guidance on fit testing of SCBA facepieces. This adapted facepiece is then self-donned by a specific number of human test subjects and evaluated per the NIOSH LRPL standard test procedure. The live agent tests and the corn-oil test are considered the three special CBRN tests required for certification of a SCBA seeking NIOSH-approved CBRN protection. These special CBRN tests are implemented by policy, not rulemaking, under the provisions of 42 CFR Part 84, paragraph 84.63(c).

- How does this relate to the NIOSH approval sought by equipment purchasers in the competitive bid processes of selling respirators? If the respirator fails a specific number of CBRN tests it does not get approved. It is that simple. Administratively, there is a public electronic application process in place, called the SAP, which tracks the status of the tests. NIOSH uses that administrative process to lead the civilian respirator global market place.

- The certification of respirators per the administrative standard application procedure (SAP) for compliant approval holders is complex and difficult for the novice. The following is a synopsis of one aspect of that procedure-the final review. A NPPTL administrative review of tested respirator part numbers that demonstrate passing results under Tier 3 is conducted during the final review of the application submitted to NIOSH/NPPTL by the respirator manufacturer. This is compared by SEI to the parts number list that shows compliance with NFPA 1981. If any part number changes, material changes, or air-pressure boundary changes are made to allow the SCBA to pass CBRN testing, those changes must be documented by NFPA and NIOSH. The final approved assembly matrix review done by NIOSH/NPPTL federal examiners compares the parts list and generates a status of the review as a number of misses or a clean review/Go or No Go. When a Go, the approved assembly matrix listing all CBRN SCBA possible configurations is then reviewed for any

final changes by the NFPA accredited certification organization offering NFPA 1981 certifications (Safety Equipment Institute (SEI), in this case) and then NIOSH/NPPTL for final compliance certification. All part numbers must demonstrate NFPA compliance and special CBRN test compliance or be removed from the NIOSH CBRN SCBA assembly matrix prior to the issuance of a NIOSH approval letter. This formal documentation serves as a quality control measure to ensure respirator systems are manufactured to recognized quality specifications while supporting the performance test record of the respirator. The three tier approval process provides a SCBA that carries a tri-fold approval: industrial, fire resistant and CBRN protected. A multi-purpose respirator designed to protect users in industrial hazardous workplaces, fire and hazardous materials workplaces and CBRN incidents.

CBRN SCBA IS A MULTI-PURPOSE RESPIRATOR

The only certainty during a terrorist event is the unpredictability of the type and magnitude of the hazard. In explosions, fire hazards are often, if not always, present. Whether a CBRN agent is dispersed in an improvised explosive device (IED) or vehicle borne detonated munition, fire hazard protection, as well as chemical warfare agent protection, will be needed. These protections are provided by the NIOSH-approved CBRN SCBA whereas, the traditional NIOSH-approved SCBA does not have fire hazard or chemical warfare agent hazard protections. That is why it is important to know the distinctions between a NIOSH-Approved SCBA and a NIOSH-Approved CBRN SCBA.

Firefighters, emergency medical technicians, federal response agents, and explosive ordnance disposal (EOD) specialists are examples of SCBA users that benefit from the fire resistance protection awarded by the second tier of the NIOSH CBRN SCBA approval process. Law enforcement responders conducting breaching operations, entry, or rescue operations may also encounter fire hazards during clandestine lab intervention, barricaded suspect or CBRN weapon threat mitigation incidents. However, law enforcement responders (LER), while needing fire resistance, do not necessarily need redundant air pressure alarms integrated into contemporary SCBA. And conversely, they may require enhanced ballistic protection of SCBA cylinders under high threat response scenarios. Special weapons and tactics officers need CBRN protected SCBA but they also need silent operating units that do not compromise their advantage of surprise or tactical approach. Their presence cannot be detected by the terrorist or criminal element during entry operations.

A new unique, NIOSH-approved CBRN SCBA standard adapted for law enforcement responder requirements is warranted. Per recent stakeholder input and NIOSH assessment of law enforcement training events, a higher percentage of special weapons and tactics officers are using SCBA to respond to airborne hazard conditions. As SCBA use increases, and municipalities continue to bid and evaluate CBRN SCBA, law enforcement officers are beginning to play vital roles in the selection of a type of SCBA. In most cases, they prefer to see certain non-essential components removed from the CBRN SCBA while adding greater ergonomic advantages of use related to weapons sighting, quieter breathing valves, reduced light and noise signatures, and instant emergency release or protection from catastrophic kinetic energy discharge.

If a first responder wants to obtain details on CBRN personal protective equipment (PPE), i.e., how to procure equipment by line number and available marketing endorsements, the responder can contact a respirator

manufacturer, contact NIOSH, or log on to the NIOSH Certified Equipment Listing (CEL) or the DHS funded, Responder Knowledge Base (RKB). The RKB search engine is a popular tool available to local and state officials seeking federal homeland security grants. The RKB search engine is provided by the National Memorial Institute for the Prevention of Terrorism (MIPT) and is located at http://www1.rkb.mipt.org/.

LIFESAVING FEATURES

Unlike industrial workplace environments where hazards are characterized and expected to be controlled, hazards at a terrorist event are expected to be initially, or subsequently unknown or masked, and likely to be uncontrolled during the early phases of emergency response. First responders to a CBRN incident may encounter mild or severe to extremely hazardous conditions, in addition to local aftermath disaster hazards, than those normally encountered in either industrial, civilian emergency response or low intensity military conflicts.

The NIOSH-approved CBRN SCBA provides the wearer with respiratory protection in potential, known, or unknown hazardous settings or environments. It may be used for entrance into and escape from atmospheres that are immediately dangerous to life and health (IDLH) or oxygen deficient. All NIOSH-approved CBRN SCBA listed on the NIOSH website are NFPA and NIOSH CBRN compliant and may be used for traditional industrial hazardous material, firefighting, and CBRN/WMD incident response. Buyers beware though! Not all components or accessories offered by respirator manufacturers are NIOSH-approved for use on the NIOSH CBRN SCBA. Users should check with the manufacturer representative and the NIOSH approval label to confirm whether or not a part number of a respirator is NIOSH-approved and carries CBRN protection compliance. The approval label is printed on white paper and is required to be inserted in the user's instructions/manual for the SCBA.

If users are really serious about knowing capabilities of a NIOSH-approved CBRN SCBA, they should be trained to interpret the approval label and become familiar with the numerous part numbers that make up an approved CBRN SCBA configuration. All of the part numbers, when fitted together in a specific design, create lifesaving features and benefits. Examples of these lifesaving/mission support features are the heads-up display (HUD), redundant, dual, and primary air-pressure gauges, PASS device, communications devices, cylinder neck valve assemblies, cylinder types and respirator end of (remaining) service time indicators (EOSTI). These features on a NIOSH-approved CBRN SCBA respirator provide the user the operational status of SCBA before, during and after use. Additional lifesaving features are the rapid intervention crew (RIC) fittings and by-pass purge valves. The technical details describing the HUD, air pressure gauges, EOSTI, RIC UAC/RIT fitting, by-pass valves and cylinder valve interchangeability are as follows:

Heads-Up Display (HUD)

The heads-up display (HUD) is a design requirement for SCBA compliant to NFPA 1981, 2002 edition. The HUD is visible to the wearer when the respirator is donned and operational. Depending on the type of HUD technology in use, a HUD can be mounted inside or mounted outside the facepeice. Its visible display shows cylinder pressure, system status and alert signals in the form of light emitting diode (LED) color readouts or other signal devices.

At a minimum, the HUD will display the remaining quantity of breathable air, a measure of real time cylinder pressure, and will alert the user when the remaining quantity of breathable air is less than 50% full. Power sources for the HUD are usually electronic. When batteries are used in the HUD, a two-hour battery life alert is a required feature. Wireless remote HUDs or HUDS with integral wiring are also on the market and the wiring is tested for strength and effectiveness.

Currently, fielded NIOSH-approved CBRN SCBA are compliant to the NFPA 1981 standard, its 1997 edition, *or* the NFPA 1981 standard, 2002 edition. As for the HUD on CBRN SCBA, a HUD is present only on NIOSH-approved CBRN SCBA that have been compliant to NFPA 1981 standard, 2002 edition or equivalent.

Gas or Air Pressure Gauges

Pressure gauges indicate the quantity of breathing air remaining in the cylinder. Pressure gauges are required to be redundant and visible to the wearer at all times. The primary air pressure gauge can be a mechanical gauge that operates with the pneumatic air pressure of the SCBA or a visual signal continuously displayed as part of the facepiece heads-up display.

EOSTI: End-of-Service-Time Indicator(s)

End of (remaining) service time indicators (EOSTIs) are required to alert the user when the cylinder is low on air. Typically, EOSTIs consist of either an audible alarm (whistle), a visually flashing LED light in the heads-up display of the facepiece, or a vibrating alarm. Depending on the edition of the NFPA 1981 requirement that was current during the year the CBRN SCBA was approved, some units could have more than one independently operating EOSTI, each of which will be recognized by different human senses. Activation of the alarm of each EOSTI shall be independent of any other EOSTI, per NFPA 1981, 2002.

RIC UAC or RIT Fitting

The rapid intervention crew/company universal air connection (RIC/UAC) male fitting also known as the RIC/RIT fitting, is an air connector that transfers or replenishes breathing air to the SCBA breathing air cylinder without the user having to remove the cylinder from the SCBA harness assembly. The RIC fitting is a design requirement only on CBRN SCBA approved under the NFPA 1981, 2002 edition. It is not present on NIOSH-approved CBRN SCBA certified under the NFPA 1981, 1997 edition.

By-Pass Valves for Use in the Event of Regulator Failure

High-pressure air from the cylinder is reduced as it passes through the first and second stage regulators, and finally, the high-pressure air is reduced to a variable low pressure volume of air that is delivered to the facepiece at a rate determined by the physical demands of the user while attempting to maintain a positive pressure within the interior of the facepice. NIOSH approval requirements specify that the regulator must fail "open" or allow the continuous flow of air into the facepiece, or be equipped with a manual by-pass valve that will override the failed regulator in the event the respirator's regulator fails "closed." NIOSH testing requires that the SCBA second stage regulator fail in the open position. In the event that a second stage regulator fails in the "closed" position, air flow will stop flowing into the facepiece. That failed second stage regulator can be manually by-passed by the user opening the red by-pass valve, to the purge/on position. Opening this red by-pass (purge) valve sends air flowing directly into the facepiece. Manufacturer's user's instructions specify

how to use the by-pass valve in the event of a regulator failure. By-pass valves expend pressurized air at a higher rate than the second stage regulator and will deplete the air cylinder rapidly. There are two types of by-pass valves: constant flow by-pass valves and variable flow by-pass valves. By-pass constant flow valves are considered state of the art technology and commonly found on CBRN SCBA. Other types of by-pass values, such those on belt-mounted regulators of SCBA, currently do not have NIOSH-approved CBRN approval.

SCBA System Rated Service Time

A CBRN SCBA "System Rated Service Time" is the same time concept associated with the rated service time of an industrial or non-CBRN SCBA. It is the length of time in minutes that an SCBA will continue to deliver breathing air to the facepiece at a specific use rate, tested in accordance with 42 CFR Part 84. This is a reproducible laboratory "bench test time" and this time is not equivalent to a human breathing performance time. Traditionally, the NIOSH system rated service times of breathing gas (air) cylinders are 30, 45 or 60 minutes in the U.S. They are assessed during NIOSH certification testing of the air cylinder capacity.

One commonly used practice is to identify the SCBA rated service time by verbally calling out the time value in minutes for a particular type of air cylinder/bottle. For example, SCBA may be known as having a 30-minute bottle, a 45-minute bottle or a one-hour/60-minute bottle on them. If a responder wanted to se the rated service time of a NIOSH approved SCBA, the rated service time of a CBRN SCBA is located on the SCBA backframe harness in the form of an adhesive NIOSH approval label, usually of rectangular dimension. The adhesive label color and printing varies by SCBA manufacturer but its location is standard as is the information on it, in accordance with 42 CFR Part 84. Rated service time is also explained in the NIOSH paper approval label inserted in the manufacturer's User's instructions and on the official electronic NIOSH assembly matrix maintained by NIOSH.

An example of a typical rated service time on an inserted approval label is listed under the protection column of the label and as an example, reads "SC/PD/CBRN 30 min/4500 psig." PSIG stands for pounds force of pressure per square inch gauge (excluding atmospheric pressure). This SC/PD/CBRN 30 min/4500psig translates into SC = Self-Contained, PD = Pressure Demand, CBRN is the additional protection category added, and "30 min" is the 30-minute rated service time at a 4500 psig pressure duration rating. Different manufacturers may identify specific rated service times or pressure durations of SCBAs by unique names such as "4.5," "2.2," "3.0," or "L-30" etc., in marketing the SCBA. The official rated service time of a CBRN SCBA is approved, per the manufacturer's application request and the findings of NIOSH certification testing.

While time or "rated service time", as it is formally called, is understood by the trained responder as the type of cylinder attached to the SCBA, such as a 30-minute, 45-minute or 60-minute bottle, the air pressure rating in psig of those same cylinders is not always as easily understood. For example, an open-circuit, pressure-demand, SCBA, capable of mounting 30, 45 or 60 minute bottles may have a variable number of types of approved air pressures/ratings, 4500 psig, 3000 psig or 2216 psig, for those cylinders on one NIOSH approval label: Resulting in a multitude of SCBA configurations for use. With a few exceptions; 2216 psig rated cylinders are typically not used on a 60-minute rated service time SCBA. An air pressure rating of 4500 psig is an example of a type of air pressure rating that can have all three types of rated service times (30, 45 or 60 minutes) in the form of different sized cylinders for a SCBA.

The NIOSH-approved rated service time of an industrial SCBA is typically based on air consumption at a moderate work rate (40 liters/minute) performed under laboratory conditions. This is also the case with the NIOSH CBRN SCBA. High work rates and differences in user lung capacity can significantly reduce or alter the actual service time achieved. As mentioned previously, CBRN SCBA rated service times are equivalent to the industrial rated service time ranges as per the first tier of CBRN approval for SCBA. Add the NFPA compliance breathing rate as a requirement of the second tier of CBRN approval and the differences in work rates are covered by using a CBRN SCBA versus a non-CBRN SCBA.

CBRN SCBA "actual service time" is usually less than the rated service time indicated on the label, due to variables such as the physical condition of the user, the level of physical exertion, the initial cylinder start pressure levels, the ambient temperature of use, and other conditions.

When the NIOSH bench mark survey was done in October 2001, 18 SCBA were evaluated by RDECOM, then SBCCOM, Edgewood Chemical Biological Center, Bldg E-5100, using adopted joint RDECOM/NIOSH test protocol. During this bench mark survey, breathing gas cylinders were attached to the SCBA per manufacturer's instructions and house air was shunted into the air pressure boundaries to allow for special chemical warfare agent test times to exceed the rated service time of the cylinder. Since that eventful bench mark survey was completed, it was determined that only the cylinder neck valve assembly of the cylinder and not the entire cylinder and cylinder neck valve assembly were needed for the SCBA test. Therefore, currently, CBRN SCBA cylinders are not tested against live agents, only their appropriate docking cylinder neck valve is.

To accomplish this NIOSH, RDECOM and stakeholders designed tooled metal adapters to interface the incoming high pressure air. The appropriate cylinder neck valve assembly is adapted via the proper torque foot pounds of pressure, to a tooled specified adapter that interfaces with a house air pressurized air line cascaded to dedicated industrial air compressor(s). Live chemical warfare agent contamination in the six-hour test prevents the quick fill or exchange of empty air cylinders for full air cylinders during the testing cycle, and thus, continuous cascading air pressure is maintained to the SCBA hardware, minus a cylinder, through the adapted cylinder neck valve. This eliminates the expensive and time intense task of decontaminating and destroying a DOT exempt pressurized vessel/cylinder.

Cylinder Compliance

Breathing air/gas cylinders used with SCBA hardware are classified as air-compressed, UN-1002, pressurized vessels, by the U.S. Department of Transportation. The DOT regulates the shipping, labeling, qualification, and periodic re-qualification of these pressurized vessels. Cylinders are tested and maintained as prescribed in 49 CFR 173 and 49 CFR 178, Shipping Container Specification Regulations, DOT. The respirator manufacturer can provide specific guidance on reading and interpreting the DOT markings on cylinders and how the hydrostatic test date markings are updated when a cylinder is re-qualified. OSHA requires that compressed breathing air for atmosphere supplying respirators, which includes the CBRN SCBA, must at a minimum, meet the requirements of Grade D breathing air described by the American National Standards Institute (ANSI) or the Compressed Gas Association (CGA) Commodity Specification for Air, G-7-1, 1989 [OSHA 1910.134 (i), (1), (ii)]. The NFPA 1989, *Standard on Breathing Air Quality for Fire and Emergency Services Respiratory Protection*, 2003 Edition, is also a reference.

Interchangeable use of pure oxygen and breathing air is not permitted in the industrial approvals or the CBRN approvals for SCBA.

Quick charge, also known as "rapid fill/quick fill" is a process used to rapidly fill an empty air cylinder still mounted in the SCBA harness assembly while worn or unworn. Quick charge utilizes supplied air from a CGA compliant cascade air supply source and is done only at the explicit discretion of the fire scene or incident commander. Quick charge assemblies on CBRN SCBA are NIOSH approved as part of the CBRN SCBA air pressure boundary, but **not CBRN approved** for actual use in a CBRN environment because the interfaces required for safely mating connections to air sources are not live agent tested, since that would involve certifying the air pressure boundary of another device that is not a respirator. Users should ensure all safety measures are enforced if quick charge operations are used. CBRN SCBA should be refilled in a prescribed air pressure refill operation procedure. Ensure mismatch of pressure ratings are not inadvertently mixed up during cylinder re-fill. This will prevent over-pressurization of cylinders and rupture of frangible discs.

During cylinder recharging, numerous inspections of the cylinder and SCBA also can be performed. A CBRN SCBA user should inspect the air cylinder for the proper shape or roll of the cylinder to ensure it conforms to an available standard, any unusual wear and tear indicators, any discoloration from burns, cracks in the cylinder thread or cylinder neck valve housing or any clogged holes in the burst disc/plug in accordance with the manufacturer's inspection procedures. A full cylinder is then attached to the SCBA hardware and the SCBA is checked for proper pressure redution between regulators by conducting user function checks on the SCBA. Typically, the maintenance management of DOT hydro-static test dates and other related cylinder maintenance programs are controlled by the issuing fire department qualified technicians. However, individual fire department standard operation procedures may require end users to physically check the hydro-static test date for expiration and process the cylinder for re-qualification. For fire departments compliant to the codes of the National Fire Protection Association (NFPA), specific NFPA codes such as NFPA 1404 and NFPA 1500 require regular maintenance checks of the hydro-static test dates. Law enforcement departments that use non-CBRN SCBA or CBRN SCBA should have officers or technicians trained by the respirator manufacturer on how to conduct SCBA maintenance programs. Mutual aid support from local fire department resources is also a very common, if not the most common, method for a SCBA maintenance program used by law enforcement responders.

Hydro-static test dates are labeled on air cylinders. Composite cylinders (carbon, fiberglass and Kevlar®) rely on epoxy resin label updates readable on the body of the cylinder in the form of a three figure code. The three-figure code (7 ^ 05) stands for the month-"7", followed by a unique inspector mark "^" and then the calendar year two digit number "05". This means the cylinder is due for a hydrostatic test in July of 2005. Other cylinder materials, such as aluminum, rely on metal digit imprints in the neck cylinder area, which are similar to the preceding figure code example. Figure XX, generic breathing gas/air cylinder schematic shows an example DOT exemption certificate label on a SCBA 4500 psig cylinder.

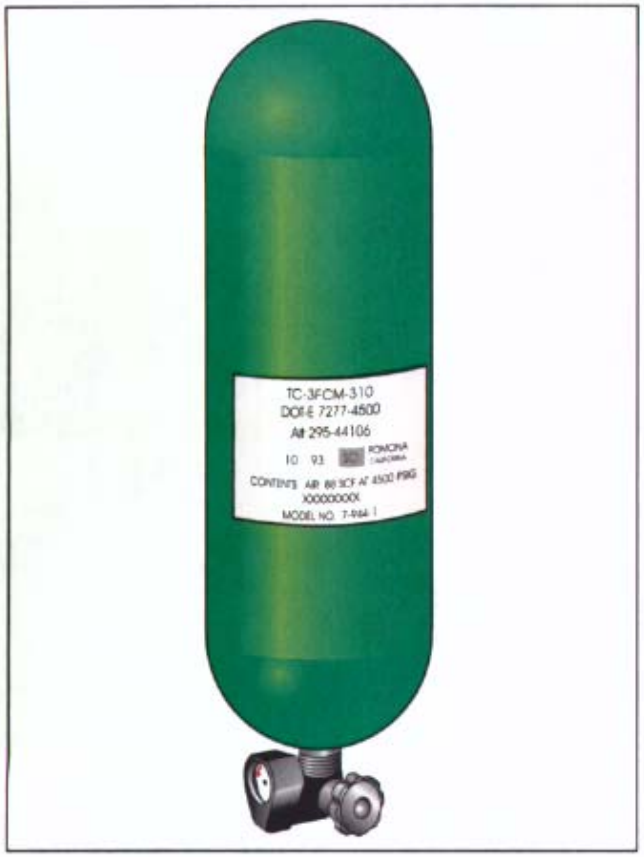


Figure XX: Generic breathing gas/air cylinder.

Figure XX: Empty cylinder stack showing field deployed condition and tagging.

Industrial Protection

Traditional SCBA respirators used to fight fires or conduct law enforcement methamphetamine lab responses are not adequate for CBRN incident responses. Traditional "industrial protection" for respirators refers to industrial workplace respirators approved under NIOSH 42 CFR Part 84. This certification ensures that the industrial SCBA meets existing minimum SCBA performance requirements consisting of maximum 35 lb weight, service life indicators, gas flow, service time, carbon dioxide, low temperature exposure, reliable use tests and human subject man tests. The CBRN SCBA program adapted the industrial protections protocol and used those same industrial proven test measures to insure initial compliance for the CBRN SCBA.

CBRN SCBA are compliant to all industrial standards and are traditional open circuit, positive pressure, or pressure demand apparatus, with additional special CBRN protections. CBRN SCBA are respirator devices in which the pressure inside the facepiece, in relation to the immediate environment, is required to maintain a slight positive pressure on laboratory head-forms during both inhalation and exhalation cycles.

While this positive pressure appears to be adequate for traditional SCBA used in industrial confined spaces and industrial hazardous materials response, and firefighting, chemical warfare agents are not stopped by this positive pressure inhalation-exhalation cycle on regular industrial approved SCBA, and thus are determined to be inadequate for CBRN incident response.

CBRN incident response has been referred to in the end user community as nothing more than "HAZMAT with an Attitude." NIOSH NPPTL CBRN respirator standards development and certification programs show that specific chemical warfare agent effects on non-CBRN protected SCBA and other respirators are more than the commonly known/expected hazardous materials effects on the same surfaces. Surviving a "terrorist grade" CBRN incident response will require that trained emergency responders use NIOSH CBRN approved respirators, use available live agent tested protective suits compatible with those CBRN respirators, and have the situational awareness that provides entry and escape confidence under severe CBRN conditions designed to attack human physiology.

CBRN hazards that are large in scale and severity will not easily dissipate under normal environmental conditions. If and when CBRN agents are used, military and civilian history indicates that the trained responder will focus on the mission and expect the personal protective equipment to provide its certified level of protection. The performance of the CBRN respirator will become paramount only if it fails during the course of the mission.

Interchangeability of Cylinder and Cylinder Valve Assemblies on Different SCBA

NIOSH CBRN SCBA approval is voided if another cylinder and cylinder neck valve assembly, not listed on the NIOSH approval label, is attached to a different manufacturer's SCBA hardware. In crisis response situations were OSHA requirements are not enforced, interchangeability between like cylinder valves and cylinder dimensions is possible. The OSHA interpretation letter on cylinder interchangeability, dated June 20, 1997, is located at
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=23479

Findings from select NIOSH/RAND reports show responders may require a viable option for the interchangeability of SCBA cylinders when several different organizations operate at a large-scale incident. On November 23, 2004, the InterAgency Board for Equipment Standardization (IAB) requested that the NFPA address the issue of how to make interoperability of SCBA cylinders a requirement of the NFPA 1981 standard. The NFPA is considering a change that addresses an interchangeability requirement in the upcoming NFPA1981 2007 edition, authorizing interchangeability of a universal NFPA cylinder and a cylinder neck valve assembly for manufacturers seeking NFPA compliance. If the NFPA change is implemented, NIOSH believes the concept of cylinder and cylinder valve assemblies manufactured to NFPA defined criteria and verified as NFPA compliant may be a workable solution to permit the NIOSH approval to remain valid for respirator configurations where the cylinder and cylinder valve assemblies of various manufacturers can be interchanged, if certain conditions are met.

Those conditions are as follows: First, the NFPA defines and develops a common set of technical requirements and quality control provisions applying to each cylinder, to include the cylinder and cylinder valve assembly, produced and shipped to be used in a NIOSH-approved configuration as part of a NFPA standard. The cylinder and cylinder valve assembly can be assembled by the cylinder manufacturer, the respirator manufacturer or other recognized assembler. Second, a certifying authority would need to conduct a program to verify and authorize labeling to indicate conformance with the NFPA standard. Third, the NFPA

compliant assemblies would need to have specific part numbers to identify the cylinder and valve assembly's pressure rating and capacity that would be used universally throughout the industry.

The manufacturer's notarized verification of the cylinder and cylinder valve assembly to be NFPA compliant would be sufficient to document the meeting the NIOSH approval requirements for the assembly. Only NFPA compliant universal cylinder and cylinder neck valve assemblies compliant to NFPA 1981-2007 edition would be viewed as NIOSH approved if used in a CBRN large scale incident. NIOSH approval can be maintained, even during cylinder interchanging, as long as the cylinder/valve assembly, with all the requirements of NFPA 1981-2007 edition and NIOSH CBRN are maintained. The use of a non-NFPA compliant universal cylinder and cylinder neck valve assembly on a NIOSH-approved CBRN protected SCBA would void the NIOSH approval. Engineer drawings and product inspection are two methods to educate the user in the complexities of the universal cylinder and cylinder valve assembly.

The attached *Appendix B, Components of a NIOSH-approved CBRN SCBA* depicts a schematic of a SCBA and shows the most common components and names on an air-hatch type CBRN SCBA. It is intended to be a generic example and does not necessarily show full accessories details in components such as the RIT/UAC, HUD, PASS or cylinder neck valve assembly and cylinder. For more detailed drawings consult with the SCBA manufacturer. *Figure XX, Air-flow pattern of SCBA cylinder* shows standard air-flow directions when the air source is the assigned cylinder. Blue arrows show air flow origin (A) relative to the location of the frangible disc (B), the hand operated valve (C), the air-pressure gauge (D) and the exit route (E) to the 1st stage pressure reducer/regulator. *Figure XX, Processing Cylinder Neck Valves and PASS device battery* shows the intricacies of the cylinder neck valve and the relationship of size between the valve and a 9volt battery for a PASS device.

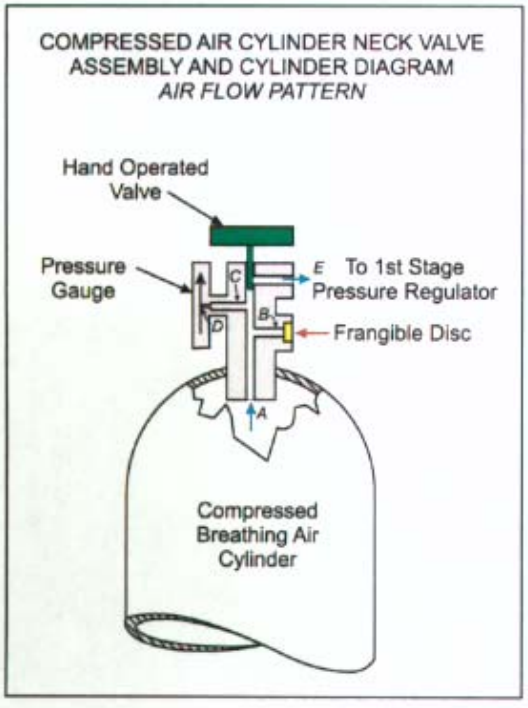


Figure XX: Air-Flow Pattern of SCBA Cylinder

Figure XX: Processing cylinder neck valves and PASS device battery.

Why CBRN Protection for a SCBA?

The majority of industrial SCBA show failing test results when exposed to vapor or liquid chemical warfare agents. CBRN protection is granted to voluntary participant manufacturers who submit passing respirators to the NIOSH CBRN respirator approval process. When awarded the NIOSH-approval for CBRN protection, the SCBA is considered CBRN protected and capable of providing known protective capabilities under known laboratory concentrations of chemical warfare agent. The same SCBA that demonstrates CBRN protection qualities must first comply with current NFPA fire resistance standards and NIOSH industrial standards. Therefore, CBRN SCBA is not a one-time-incident SCBA under normal use criteria. It can maintain its CBRN protective qualities while it is used in routine fire or hazardous material responses.

CBRN SCBA are multipurpose in that they provide the same level of protection to the end user whether it is a structural fire, hazardous materials, "meth lab," riot control agent, chemical agent or biological toxin response. However, when it is a chemical agent response, such as GB or HD, a limiting factor comes into play. For the safety of the responder, NIOSH-approved CBRN SCBA have defined use lives when exposed to CWA. CBRN SCBA are one-time-use respirators due to the known permeation and penetration characteristics of chemical warfare agents and the inability of surface decontamination to totally neutralize the CWA on the CBRN SCBA.

The fact that a respirator carries a NIOSH-approval for protection against CBRN agents and the fact that this specific type of respirator is being bought by emergency responders and civilians alike, may deter a terrorist from using or deploying a CBRN agent, cause the terrorist to adjust planning measures to compensate for the known protection or have no deterrent effect. To deter is to prevent or discourage from acting, especially by means of creating doubt or fear. By the terrorist knowing CBRN approved respirators exist, this fact coupled with many other facts, may create doubt as to the magnitude of effectiveness from releasing a chemical warfare terrorist agent and the planned effects of a CBRN terrorist incident may not achieve the expected results from a secondary or tertiary device on soft targets like emergency responders. History shows that chemical warfare agents are more apt to be used on unprotected to inadequately protected military forces or civilian populations. The better prepared the emergency responder is the better chance of surviving an attack.

Deterrence is the act or means of deterring and, in the state government arena, it is the measures taken by a state or an alliance of states to prevent hostile action by another state [Webster's, 2001]. Most public evidence points to U.S. nuclear and conventional weapons technology as deterrents that contributed to the end of the Cold War. With this same perspective in mind, acts of deterrence, such as those currently instituted by the U.S. Department of Homeland Security, may contribute to the failure of international terrorism on U.S. soil and perhaps abroad.

CBRN protected respirators currently contribute to the deterrence of CBRN acts of terrorism while increasing the national inventory of respiratory protective equipment available to crisis and consequence management responders for both industrial, fire and CBRN responses. The U.S. Department of Homeland Security National Response Plan (NRP) describes crisis management as predominately a law enforcement function and includes measures to identify, acquire, and implement the use of resources needed to anticipate, prevent and/or resolve a threat or act of terrorism [NRP, December, 2004]. Conversely, the term "consequence

management" is viewed by the US Department of Homeland Security as predominately an emergency management function and include measures to protect public health and safety, restore essential government services, and provide emergency relief to governments, businesses, and individuals affected by the consequences of terrorism. The requirements of consequence management and crisis management are combined in the NRP and therefore are not likely to be as easily separated as they were during the New York World Trade Center response [NRP, December, 2004, page 64]. CBRN SCBA will perform to the same high standard regardless of whether the response is a crisis or consequence management incident timeline.

CBRN SCBA are significantly more complex compared to the engineering design requirements of CBRN air-purifying respirators. Numerous air-pressure boundaries exist in SCBA, and CBRN agents rigorously attack all respirator materials, air pressure boundaries and interfaces of that SCBA, as they do in an air-purifying respirator but to a lesser degree because there are fewer parts comprising a CBRN APR. CBRN SCBA design requirements and technology have made rapid advances over the past three years to ensure that any given approved design allows the SCBA to provide the minimum amount of quantifiable chemical agent protection, as determined under ideal laboratory conditions.

If there is air pressure disequilibrium due to respirator valve orientation, respirator valve material porosity, or respirator material tooling design flaws, GB exhibits undefined chemical traits that allow it to penetrate and permeate the materials or flaws and potentially create agent equilibrium between the interior of the respirator and the exterior GB concentration. The Venturi effect may account for why GB and HD penetrate between static and cyclic air-pressure boundaries of select respirators and, in fact, gain variable access to the breathing zone of a SCBA. Parameters of this same Venturi effect coupled with the dynamics of Bernoulli's Principle could explain why so-called dead spaces, also commonly referred to as compartmentalized material chambers that do not experience air pressure changes or air flow dynamics, allow GB to build up and actively penetrate/permeate the respirator, or be flushed out by air exhalation cycles. This process of dead space air exhalation cleaning has been demonstrated during NIOSH certification to be one of the engineering design controls used to protect air pressure boundaries against GB penetration or permeation.

It is a commonly understood phenomenon that GB aerosol will penetrate or permeate silicone surfaces that are used as respirator air valves or facepiece materials, provided there is minimal, to zero air flow/movement over the material surface. Government laboratory experiments confirm that various thicknesses of silicone swatches will allow permeation and penetration of GB, HD and VX, at various time intervals. While silicone is recognized as an ideal air pressure boundary for industrial use, its use in a CBRN approved respirator is limited by the fact that it allows agent to penetrate or permeate it. The amount of concentration gradient penetration that passes through silicone is dependent on the level of GB concentration, silicone material thickness and time of exposure. Of course, GB and HD hardened/resistant materials that do not contain silicone or have blends of butyl rubber appear to be ideal CBRN protection facepiece materials under live agent laboratory conditions. Currently, silicone materials are common in many types of respirators and for select applications such as a biological agent response or a low grade chemical warfare agent response, silicone materials may still be used but will require insulation for protection against CWA affects.

Please remember that NOISH laboratory conditions are practical and not designed to fully replicate CBRN field use conditions of all possible venues of terrorist attacks. Rather the concentration values are based on the most credible chemical warfare agent event predicted parameters and refined with safety factors to generate a pass/fail criteria for respirator performance. The NIOSH special CBRN tests do replicate rigorous

repeatable laboratory processes that stress CBRN SCBA air pressure boundaries and external material compositions. Contamination concentrations are known and calibrated laboratory equipment allows the controlled observation, documentation and quantification of agent exposure affects resulting in certifiable test results for NIOSH approval letters. The fact that a confined space is created in a laboratory environment produces conditions that replicate various worst case scenarios that may in fact occur in the field environment workplace.

Material surfaces that are treated may also be barriers to the affects of CWA. Hard, non-porous surfaces, like coated polycarbonate, will allow liquid HD to drain off and will most likely not allow the surface to be permeated unless the HD agent is allowed to collect in a lip or threaded area. If the HD agent is allowed to collect or pool in an area of the respirator, tests show that HD permeates and grazes the material over time.

This is one of the reasons why timely gross decontamination with a decontaminant solution is expected to slow the permeation effects of select CBRN agents.[1] Liquid HD is known to aggressively attack thin plastic membranes, silicone membranes, stress points where two like or different materials interface, and other porous surfaces, causing pressurized or mated surfaces to violently expand, crack, and physically crumble under slight external pressure or internal mating surface pressures exerted by pneumatic pressure boundaries or changes in material compositions.

CBRN protected respirators, tested and approved in laboratory environments, are currently designed to protect against intelligence templated threat CBRN agents in what has been commonly referred to as "anticipated credible events." The phrase "anticipated credible event" is confused with what is known as "worst case (use) conditions." Military grade CBRN agents are expensive to obtain, dangerous to handle and transport, and difficult to deliver by the moderately trained or untrained person. The existence of an effective protection program for emergency responders to respond to and control the hazard diminishes the potential impact of a CBRN attack and, consequently, may diminish the terrorist interest in investing time, energy and resources into this "mode" of attack.

U.S. anthrax responses during the autumn of 2001 and other listed CBRN type events compiled and analyzed by the Monterey Institute of International Studies (MIIS) in 2001, show various degrees of credible chemical and biological terrorism attempted and executed in the U.S. and the international community.

In the case of chemical warfare agents, significant attacks initiated by the Japanese religious cult Aum Shinrikyo, now called Aleph, occurred from April 1990 to April of 2000 in Japan. CBRN agents of choice for the Aum Shinrikyo cult were VX, GB, variations of anthrax cultures and anthrax vaccine strains, variations of botulinum cultures, phosgene, hydrogen cyanide, sodium cyanide, sulfuric acid mixtures and hydrogen fluoride. The use of radiological agents by the cult, in the form of dirty bombs, was not identified by the MIIS 2001 assessment. However, MIIS did identify radiological incidents or "rad attacks" as termed by the MISS that were planned and foiled.

CBRN agent physical constants (density, vapor pressure etc.) make them ideal inhalation threats and thus, the respiratory system is considered by most scientists as the primary route of entry into the human body followed by dermal exposure. Unprotected personnel have historically been the targets of chemical warfare agents or

[1] XXXXX

irritants. Irritants such as tear gas, the riot control agent CS, mace, pepper spray or some other irritant were sprayed in the first class cabin of the commercial jet American Airlines Flight 11 to apparently force passengers and flight crew toward the rear of the aircraft [9/11 Commission Report, page 5, 2004]. The use of an irritant in the hijacking of American 11 shows the aptitude of the terrorist to understand the immediate effects of irritant particulate agents and the psychological outcomes resulting in intimidation and terror.

Integrating CBRN agents into a focused pre-planned terrorist attack is not expected to be easy for the terrorist, however, if the 9/11 attacks are indicators of terrorist planning capability and mission execution, the potential use of CBRN agents or riot control agents in future terrorism incidents cannot be discounted [http://edition.cnn.com/SPECIALS/2002/terror.tapes/].

CBRN agents may be one of the terrorist tools of primary or secondary choice in the next attack. CBRN protection, afforded by NIOSH approved CBRN SCBA, is the highest level of respiratory protection available. And when properly maintained, stored, and used it is expected to provide that level of protection for the life of the SCBA. The types of CBRN agents are briefly discussed to show relevant cautions in using the NIOSH-approved CBRN SCBA.

TOXIC INDUSTRIAL CHEMICALS and TOXIC INDUSTRIAL MATERIALS

Airborne Industrial Chemicals, Toxic Industrial Chemicals, or Toxic Industrial Materials (TIC, TIM): TIC and TIM are chemical elements, compounds or materials used in industrial applications that exist in the physical states as gases, vapors, liquids, solids, or particulate aerosols. The difference between a TIC and a TIM is the physical state of the compound and whether the compound is mixed with other compounds or undiluted.

Toxic Industrial Chemicals (TICs)

Toxic industrial chemicals are a variety of industrial chemicals used in civilian or military industrial processes that can kill, seriously injure, or incapacitate people if inadvertently released into the workplace or environment. The quantity of TIC and type of TIC determines emergency response policies regarding downwind hazard evacuation or sheltering in place. Toxic industrial chemicals are normally bulk storage containers of solitary chemical compounds used to support industrial business in the manufacturing of a specific industrial product. Chlorine (CL2) is considered a TIC despite its previous use as a classic chemical warfare agent during World War I. Anhydrous ammonia (NH3) is also considered a TIC. These are just two of many TIC used in civilian industry. The U.S. Environmental Protection Agency recognizes the acronym TIC as toxic industrial chemicals but does not define it further.

Toxic Industrial Materials (TIMs)

Toxic industrial materials are a variety of industrial chemicals that are usually compatible and used in civilian or military industrial processes that can kill, seriously injure, or incapacitate people. Toxic industrial materials are often comprised of more than one toxic industrial chemical. An example is the use of an industrial waste storage press that combines several toxic industrial chemicals routed to it for the purpose of generating a solid sludge waste for controlled disposal. Industrial sludge is a TIM. Industrial waste by-products transported in

environmental waste roll-offs may also be considered TIM. Examples of TIMS are chlorine, anhydrous ammonia, phosphine, ethylene glycol dinitrate, 1, 1-dimethylhydrazine, acetylene, butane, cyclopropane, ethylene, methane, propane, gasoline, and hydrogen.

CHEMICAL WARFARE AGENTS (CWA): NERVE AND BLISTER

NERVE AGENTS

Examples of nerve agents are GB (Sarin), GA (Tabun), GD (Soman), GF (cyclohexyl Sarin), and VX. Nerve agents consist of a group of very toxic organophosphate chemicals specifically designed for military warfare. Most of the nerve agents exist as liquids, but some, such as GB, volatilize into the air on their own. GB in a liquid state has the consistency of water. Its name is derived from the four German scientists who invented it: **S**chrader, **A**mbros, **R**udriger and van der L '**IN**'de [Library.thinkquest.org]. VX, a persistent nerve agent has a consistency similar to motor oil. It is not likely to become airborne, but in conditions involving explosions, it could aerosolize/vaporize and disperse into the air. The introduction of "dusty CBRN agents" or "next generation CBRN agents" may warrant continued research into the level of protection a CBRN SCBA will provide to the wearer when exposed to these novel agents.

Additional information on nerve agents can be found at the following website:

NIOSH emergency response cards http://www.bt.cdc.gov/agent

BLISTER AGENTS

Examples of blister agents are HD (sulfur mustard), nitrogen mustard (HN-1, HN-2 and HN-3) and Lewisite (L, L-1, L-2 and L-3). Blister agents or vesicants are chemicals, which have severely irritating properties that produce fluid filled pockets on the skin and cause damage to the eyes, lungs, and other mucous membranes. HD is a liquid at ambient temperatures, but can vaporize on its own or be dispersed as a vapor in an explosion. HD, in the liquid state, permeates surfaces at the molecular level and can cause select materials to become brittle, break, or expand rapidly.

Additional information on sulfur mustard can be found at the following website:
NIOSH emergency response card for HD (sulfur mustard)
http://www.bt.cdc.gov/agent/sulfurmustard/erc505-60-2pr.asp

BIOLOGICAL AGENTS

Biological agents are particles that will not penetrate the materials of properly assembled and fitted respirators or protective clothing. Some terrorist or state-sponsored devices may have the capacity to disseminate large quantities of biological agents or materials as aerosols. Biological agents may be dispersed in the form of liquid droplets, liquid aerosols, solid aerosols, or as a powder of bacterial spores.

The CBRN SCBA provides protection against airborne biological terrorists' threats including anthrax, brucellosis, Glanders, pneumonic plague, tularemia, Q Fever, smallpox, Venezuelan equine encephalitis, viral hemorrhagic fevers, T-2 mycotoxins, botulism, ricin, and staphylococcus enterotoxin B. NIOSH respirator

policies state that under specific conditions, a properly worn and fitted traditional SCBA reduces the user's exposure to industrial hazards by a factor of at least 10,000. This reduction is true whether the hazard is from airborne industrial particles, industrial chemical vapors or industrial gases. CBRN SCBA also have the same minimum level of assigned protection, plus enhanced material protection factors not inherent in traditional industrial SCBA. Other types of respirators that provide lower levels of assigned protection are generally allowed in the workplace, once conditions are understood, defined, and exposures are determined to be at considerably lower levels due to engineering controls, portable forced air ventilation or fitted PPE.

Additional information on bioterrorism agents can be found at the following website:
http://www.bt.cdc.gov/agent/agentlist.asp

RADIOLOGICAL and NUCLEAR AGENTS/EFFECTS

Radiological agents and nuclear detonation effects create airborne particulate matter (liquid and solid aerosols), which are radioactive or have the ability to carry radioactive particles (i.e., alpha and beta particles released from the atomic nuclei of an unstable isotope cling to dirt particulates). The CBRN SCBA provides protection from breathing this particulate-borne radiation by protecting against particles suspended in air.

Protection is not provided against high energy gamma radiation, which consists of the emission of photons from the atomic nuclei of a substance undergoing radioactive decay. Protecting responders from high energy gamma radiation requires minimizing exposure time, incorporating the use of special shielding garments, and maintaining appropriate distance from the source, based on the measured radiation exposure values at the site.

Protection is not provided against the explosive energy effects of a conventional or nuclear detonation creating energy blast waves and the resulting high velocity debris, which will likely impact the wearer and the respirator.

Radiological refers to particulate-borne radiation dispersed by detonation of a radiological dispersive device (RDD) or a radiological improvised explosive device (R-IED), also known as a "dirty bomb." An RDD is understood to be a conventional explosive device that has been surrounded by or contaminated with some form of radioactive isotope material.

Nuclear refers to particulate-borne radiation dispersed by detonation of an improvised nuclear device (IND) or a nuclear warhead. An IND is intended to cause a yield-producing nuclear explosion, and could consist of diverted nuclear weapon components or a modified nuclear weapon. Unlike an RDD that can be made with almost any radioactive material, an IND requires fissionable material—highly enriched uranium or plutonium—to produce a nuclear yield.

Additional information on radiological and nuclear agents can be found at the following website:
http://www.bt.cdc.gov/radiation/index.asp

OTHER HAZARDOUS ATMOSPHERES

Unknown Atmospheres

NIOSH approved CBRN SCBA are expected to provide protection against unknown toxic compounds and oxygen deficiency in unknown atmospheres. Air-purifying respirators (APR) of any type are not recommended in lieu of SCBA or supplied air respirators (SAR) for these atmospheres. Read to the following link http://www.cdc.gov/niosh/npptl/topics/respirators/cbrnapproved/apr/default.html to understand why a CBRN SCBA is recommended over a CBRN APR for use in unknown atmospheres or atmospheres that are expected to be high in toxic compounds. Unknown atmospheres are expected to be those atmospheres in which the contaminant type and concentration is not known by the user prior to entry. A CBRN SCBA may be used for emergency or planned entry into unknown atmospheres provided the scene is secure, and proper two-man entry rules are in effect per local incident command authority. Additionally, current CBRN SCBA are not required to be intrinsically safe and therefore, lower explosive limits (LEL) must be determined to be at safe levels before entry.

Immediately Dangerous to Life or Health (IDLH) Atmospheres

NIOSH-approved CBRN SCBA provides protection against atmospheres at or close to levels considered immediately dangerous to life or health (IDLH). According to *NIOSH Respirator Selection Logic, (October 2004) and NIOSH Interim Recommendations for Firefighters and Other First Responders for the Selection and Use of Protective Clothing and Respirators Against Biological Agents*, one of the most protective respirators are self-contained breathing apparatus equipped with a full facepiece and operated in a pressure-demand mode. CBRN SCBA meets the criteria and is recommended for use in an IDLH atmosphere. This type of respirator is also selected for firefighting, entry into oxygen-deficient atmospheres, emergency situations, and entry into an atmosphere that contains a substance at a concentration greater than 2,000 times the NIOSH recommended exposure limit (REL) or OSHA permissible exposure limit (PEL) for a compound [NIOSH Pocket Guide, 2004].

The current NIOSH definition for an IDLH exposure condition is stipulated in the *NIOSH Respirator Selection Logic* [NIOSH Publication No. 2005-100]. Additionally, it can be found in the *NIOSH Pocket Guide to Chemical Hazards* http://www.cdc.gov/niosh/npg/npg.html .

In these documents, IDLH is defined as "an exposure condition that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects, or to prevent escape from such an environment. The purpose of establishing an IDLH exposure level is to ensure that the worker can *escape* from a given contaminated environment in the event of failure of the respiratory protection equipment.

The IDLH is considered a maximum level above which only a highly reliable breathing apparatus providing maximum worker protection is permitted. Any appropriate approved respirator may be used to its maximum use concentration (MUC) up to the (known) IDLH concentration." The original definition of IDLH was derived from 30 CFR 11.3(t) and the concept of incorporating a safety margin using standard completion program IDLH value was based on the effects that might occur as a consequence of a 30-minute exposure.

However, the 30-minute exposure was NOT meant to imply that workers should stay in the work environment any longer than necessary; in fact, every effort should be made to exit immediately.

Oxygen-Deficient Atmosphere

An oxygen-deficient atmosphere is defined by NIOSH as an atmosphere with an oxygen concentration below 19.5% by volume. The minimum requirement of 19.5% oxygen at sea level provides an adequate amount of oxygen for most work assignments and includes a safety factor. The safety factor is needed because oxygen-deficient atmospheres offer little warning of the danger, and the continuous measurement of an oxygen-deficient atmosphere is difficult. Oxygen concentrations below 16% at sea level produces decreased mental effectiveness, visual acuity, and muscular coordination, and below 6% oxygen, death will result. Often, only minor subjective changes as indicators are noted by individuals exposed to low concentrations of oxygen and collapse of the individual can occur without warning. Since oxygen-deficient atmospheres are life-threatening, only the most protective respirators are recommended. The most protective respirators are the pressure-demand self-contained breathing apparatus or the supplied-air respirators with auxiliary self-contained escape bottles for industrial operations and the CBRN SCBA for CBRN incident operations. See the respirator selection logic link at http://www.cdc.gov/niosh/docs/2005-100/default.html for further information.

NIOSH recommends a supplied air breathing system to ensure adequate levels of oxygen for working in oxygen-deficient atmospheres. The NIOSH approved CBRN SCBA carries an independent supply of compressed gas breathing air that is not connected to a stationary breathing air source. A compressed gas breathing air supply is required by 42 CFR 84 to meet the applicable minimum grade requirements for gaseous air set forth in the Compressed Gas Association *Commodity Specification for Air, G-7-1*, 1966 (Grade D air or higher quality) publication. Compressed oxygen cannot be used in a device designed for compressed breathing air (an SCBA cylinder) and is not recommended by NIOSH. In fact, 42 CFR 84 prohibits certification of any device designed to permit interchangeable use of oxygen and air. It is a general practice safety rule that elemental oxygen can never be used in a device unless it is specifically designed for that purpose. Grade D or E air is also used in self-contained underwater breathing apparatus (Scuba), which may be compliant to EN 14153-1 or EN 14413-1, in accordance with certification training programs endorsed or published by the Professional Association of Diving Instructors (PADI). See the following website for more information: http://www.padi.com/english/default.asp?o=am.

SCBA SYSTEMS CHECKS

The manufacturer's User's instructions (UI) give detailed procedures for performing checks of components and accessories required on CBRN SCBA. Checks include an inspection of material integrity for signs of wear or damage and an operational check of the function of the components and accessories. The manufacturer will specify in the UI what checks are necessary based on the components and accessories particular to that CBRN SCBA model. Among the checks which should be performed before use are:

- Inspection of facepiece components and accessories
- Inspection of backframe and harness assembly
- Check of cylinder valve assembly function
- Check of cylinder gauge function and that it shows the cylinder is full

- Regulator function (both first stage and second stage regulators/air hatches, compact demand valves, mask mounted regulators etc. that are first breath activated)
- Bypass valve function
- Function of all end-of-service-time-indicators (EOSTI)
- Function of heads-up-display (HUD)

- Check of integrity of hoses for cuts, abrasions, cracks, heat and chemical damage, and that the hose connections are tight
- Check that the hydrostatic test date of the cylinder is valid and not expired
- Check function of personal alert safety systems (PASS) if present
- User fit testing, seal check and technician leak testing of respirator

SCBA FACEPIECE FIT TESTING (QLFT/QNFT)

***ATTENTION*: TO ATTAIN MAXIMUM BENEFIT FROM THE CBRN SCBA, EACH END-USER MUST BE FIT TESTED BY ACCEPTABLE OSHA PROTOCOL AND ATTAIN A SATISFACTORY FIT FACTOR BEFORE USING THE CBRN SCBA IN INCIDENT RESPONSE. FAILURE TO DO SO COULD RESULT IN INJURY OR DEATH. USER SEAL CHECKS ARE NOT FIT TESTS. FIT TESTS ARE METHODICAL PROCESSES THAT CONFIRM THE SELECTED RESPIRATOR FACEPIECE SIZE IS THE CORRECT SIZE FOR THE END-USER.**

Special instruction notes concerning fit testing are as follows:

Note # 1: A clean shaven face is preferred. Proper training, supervised SCBA Facepiece fit testing and a passing fit factor from the fit-test are required for the safe use of a NIOSH CBRN SCBA.

Note # 2: Successful fit testing of this NIOSH CBRN SCBA facepiece is required prior to use.

Note # 3: NIOSH defines a "fit test," per the October 2004 respirator decision logic, as: *the use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual.*

Note # 4: Do not confuse fit testing with a user's fit/seal check. They serve two different functions. An efficient user's fit check or seal check usually cannot be performed comfortably if a passing fit test is not attained.

Note # 5: Fit testing is required in those respiratory protection programs of OSHA compliant states and highly recommended in those non-OSHA state programs.

Note # 6: Failing fit factors from inadequately performed fit tests or inadequately sized facepieces could contribute to adverse effects on the respirator wearer and lead to potentially acute or chronic lifetime effects upon exposure to characterized or uncharacterised toxic or incapacitating hazardous atmospheres.

Note # 7: User fit/seal checks are routine seal checks that are done on a properly fit tested facepiece worn by an assigned end user, to ensure a proper face-to-facepiece periphery seal interface. a proper systems function check seal is attained after initially donning the facepiece, and as necessary, resealing the facepiece while in use to prevent inadvertent contamination penetration caused by the facepiece moving around on the end user's face during routine use or increased levels of use.

Note # 8: See the CBRN SCBA respirator manufacturer user's instructions for additional information on fit testing and user seal/facepiece fit checks.

A respirator will not provide its intended level of protection unless it *fits* the user properly. Proper fit means that the periphery seals of the respirator facepiece conform adequately to the user's face while properly wearing the respirator. The fit assures a level of known protection, provided the facepiece is maintained properly and donned correctly, each time. According to conversations with experienced fire department personnel, fit testing is performed on fire department personnel who are participating in the new SCBA selection process and is one of the first actions a fire department does when a new SCBA is purchased.

Routinely, the first action performed upon receipt of a new SCBA is to conduct a facepiece system leak test. Fit testing is also a considered by decision makers as a possible resource constraint during the purchase specification development because thorough fit testing requires a leadership endorsement, a set amount of time, availability of responders, and fit testing equipment logistics. To ensure that the fire department received a high-quality production model, most fire departments do SCBA system leak testing as a first time receipt action. If all SCBA systems meet the performance criteria for leak testing and pass, then facepiece size allocation, selection and donning are done and usually followed by fit testing. The fit factor generated from compliant qualitative or quantitative fit testing methods determines the success or failure of the fit testing.

NIOSH respirator selection logic defines *fit factor* as a quantitative measure of the fit of a specific respirator facepiece to a particular individual. A *fit test* is further defined as the use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual (see also Qualitative Fit Test (QLFT) and Quantitative Fit Test (QNFT). QNFT is defined as an assessment of the adequacy of the respirator fit by numerically measuring the amount of leakage into the respirator." QLFT is defined as a pass/fail fit test to assess the adequacy of the respirator fit that relies on the individual's response to the test agent. The QLFT and QNFT definitions are from the NIOSH Respirator Use Logic dated 2004 (http://www.cdc.gov/niosh/docs/2005-100/default.html). In the course of conducting a fit test, a defined and proven method is used to select a respirator size that provides the desired protective fit. Determination of facepiece fit is to be done by either a qualitative or quantitative OSHA-accepted protocol specified in Appendix A of the OSHA Respiratory Protection Standard [29 CFR 1910.134]. The respirator program administrator is responsible for providing fit-tests to respirator users prior to initial use of the respirator, whenever a different respirator facepiece (size, style, model or make) is used, and at least annually thereafter to ensure continued, proper fit [29 CFR 1910.134(f)(2)].
Users should also undergo fit testing when changes in their physical condition occur that may affect respirator fit. Such conditions include, but are not limited to, facial scarring, dental changes, cosmetic surgery, or an obvious change in body weight [29 CFR 1910.134(f)(3)]. The OSHA Respiratory Protection Standard [29 CFR 1910.134] mandates that tight-fitting facepieces, even for positive-pressure units, be fit tested in the negative pressure mode. This includes the NIOSH CBRN SCBA.

The user should have the option to try on different sizes of CBRN SCBA facepieces (small, medium, and large, for example) converted to negative pressure configurations. In addition to the industrial fit testing for traditional NIOSH 42 CFR 84 certification, human test subjects used in CBRN SCBA laboratory respirator protection level (LRPL) are fit tested using quantitative calibrated particle analyzer machines to generate a LRPL value. In pre-LRPL trials, those individual that are difficult to fit are tested on a TSI PORTACOUNT QNFT system to confirm the available size issued. Those same test subjects participate in the required corn oil chamber test trials during the LRPL testing phase. User seal checks, performed by the CBRN SCBA test subject without assistance from a second person or expert fitter, is known as "self-donning." Self-donning and user seal checks are taught in accordance with the most current manufacturer's User's instructions. Facial hair, scalp hair lines, hair buns/tied up long hair or unshaven faces can contribute to inadequate fit testing results. Unshaven faces, hair lines that extend into the face-blank sealing area or hair buns that preclude the head harness from lying correctly, contribute to poor sealing characteristics and routinely generate failing results. Consult your local industrial hygienist or safety officer/professional for technical assistance and training before attempting to conduct QNFT or QLFT.

Facepiece Seal Leak Checks, User Seal Checks or Facemask Fit Checks

The user seal check is a method for determining whether a previously fit tested respirator has been properly donned and adjusted to ensure an adequate facepiece-to-face seal or fit. NIOSH respirator selection logic defines a user seal check as "an action conducted by the respirator user to determine if the respirator is properly seated to the face." Respirator users should perform a user seal check every time the respirator is donned and before entering a contaminated area. A user seal check evaluates the seal of the respirator to the user's face by having the user don the facepiece under positive or negative pressure and checking for leakage. Effectiveness of the user seal check is dependent on the end user or assistant detecting any audible or visual changes in the respirator indicative of an air pressure boundary leak. User seal check procedures are located in Appendix B-1 of the OSHA Respiratory Protection Standard [29 CFR 1910.134]. Manufacturer's user seal check procedures, which are located in the manufacturer's user's instructions specific to the model of respirator, are normally compliant with this OSHA reference. Specific respirator manufacturer user's instructions may advise the wearer to conduct a 'facemask fit check' [Sabre SCBA User's Instructions, March 2003]. This is the same as a user seal check. The facemask fit check is a unique process on the worn respirator, whereby the SCBA is fully donned, the cylinder valve is on, and the system charged. The wearer then inserts two fingers into the mask face blank area to break the seal and determines if there is an outward flow of air (positive pressure). Once a sense of outward air is determined, under ideal conditions and with no CBRN contamination present, the fingers are removed and the faceblank is allowed to re-seal to the face. At this point wearers may be advised to stop breathing for a few seconds and check that there is no sound or air flowing from the second stage regulator. This method for checking the fit is not recommended for use in a toxic environment.

ACCESSORIES

An accessory is an item provided with a respirator that does not affect its ability to meet the NIOSH certification requirements of 42 CFR Part 84 [NIOSH SAP January 2001a]. CBRN approved accessories are

listed as components of a respirator on the NIOSH approval label. However, in the case of CBRN protection approvals, submitted accessories must be attached and serviceable during the special CBRN LAT and LRPL trials. Batteries are not inserted in the integral or attached Personal Alert Safety System (PASS) devices because operation of the device does not expose the SCBA air pressure boundaries to ambient air and therefore, they are not exposed to NIOSH CWA test reagents. CBRN SCBA accessories may include electronic voice amplifiers, affixed hardwire communications devices, spectacle (eyeglasses) kits, integrated PASS, stand alone PASS devices, fire service rescue belts and facepiece foam seal inserts.

UPGRADE OF FIELD DEPLOYED UNITS TO CBRN PROTECTION APPROVAL

In 2002, NIOSH implemented a program to certify CBRN retrofit kits for field deployed SCBA http://www.cdc.gov/niosh/npptl/resources/pressrel/letters/lttr-031103c.html . SCBA units that were placed in service prior to issuance of CBRN approval may be upgraded to CBRN approval status through this program. Respirator users can contact the manufacturer of their current SCBA to see if a NIOSH-approved CBRN SCBA retrofit kit is available. Chapter 4, Section G, provides a detailed description of the requirements for approval upgrade of field deployed SCBA to CBRN protection.

Digital image to be inserted

Figure XX. Field deployed SCBA, minus cylinder, with CBRN SCBA upgrade kit attached and submitted for the NIOSH NPPTL initial review. Notice the red label denoting it is a CBRN rated model as well as the harness assembly labels of showing NIOSH approval.

Chapter 2: CERTIFICATION APPROVAL FACTORS

NIOSH ASSEMBLY MATRIX

NIOSH CBRN SCBA part number configuration management is done by specific software that records, manages, and compares numerous data files on a SCBA. This generates a master part number and equipment description matrix called the NIOSH assembly matrix, which is maintained in proprietary confidence by NIOSH/NPPTL. This assembly matrix is normally an electronic file that shows a table of major subassemblies and accessories assigned to a particular respirator. The assembly matrix is the technical parts data for the NIOSH approval label paper insert located with the manufacturer's CBRN SCBA user's instructions. The January 2001 version of the NIOSH standard application procedures for the certification of respirators (SAP) defines an assembly matrix as a table of major sub-assemblies and accessories and should closely follow the format of the example shown in this manual in section C. This SAP version is under currently under revision for comment as Revision 2, February, 2005. In this SAP, a typical approved CBRN SCBA assembly matrix may list both industrial SCBA part numbers and CBRN part numbers or may be a distinct and separate CBRN SCBA assembly matrix that simply tracks CBRN SCBA configurations at the discretion of the respirator manufacturer.

NIOSH APPROVAL LABEL

Only respirators affixed with an adhesive CDC NIOSH CBRN Agent Approved label as shown below are certified by NIOSH for use in CBRN environments. To determine if a respirator is CBRN approved:

- Look to see if the CBRN agent approval label is on the respirator, Figure 4. If a respirator is CBRN-approved by NIOSH, it will carry this adhesive label that has black and white lettering. The label is required to be placed on the backframe of the SCBA in a highly visible location. If this CBRN agent approved label is **not** on the SCBA, the device is **not** approved by NIOSH for use in CBRN environments.

- **Check the CBRN agent approved label to avoid use errors! If the label is worn off or unreadable, contact the manufacturer for appropriate coordination procedures to follow so that matters of liability etc. are preempted. Ensure that you read the user's instructions for all required component part numbers, accessory part numbers and specific additional NIOSH cautions and limitations prior to use.**

Digital image to be inserted

Figure XX. SCBA CBRN Agent Approved Adhesive Label.

- Additional information is provided through the NIOSH, matrix-style approval labels (paper) found in the instruction manual for the respirator. The instruction manual is shipped by the manufacturer with the respirator. The instructions manual, operating manual, operations manual or, as it is generically known by NIOSH, User's instructions (UI), outline the general safety information, warnings, cautions, limitations, liabilities and special cautions and limitations for the CBRN SCBA as defined and endorsed by the manufacturer. These CBRN SCBA UI clearly state that use of the CBRN SCBA are intended for use by personnel who have successfully completed a manufacturer training program. In some emergency responder departments, SCBA are mistakenly not considered respirators and therefore not considered subject to respirator cautions and limitations. In these same departments, respirators are considered gas masks and SCBA are considered or known as just SCBA or BA.

- While manufacturer user's instructions or operations manuals routinely refer to CBRN SCBA simply as self contained breathing apparatus, SCBA are, in fact, a separate class of respirators and not just simply self-contained breathing apparatus or breathing apparatus (BA).

- Separate classes of NIOSH approved respirators routinely have separate technical certification (TC) approval numbers. The approval number or TC number for a SCBA respirator approved for CBRN protection includes a **CBRN** suffix (TC-13F-XXXXCBRN). The Xs are sequential administrative numbers assigned by NIOSH. **If the approval number does not include a CBRN suffix, it is not certified by NIOSH for use by emergency responders in CBRN environments.**

- **The complete CBRN assembly must be composed of only those component parts listed in the row with the CBRN approval number on the approval label (paper) located in the UI.** Each SCBA manufacturer has a unique part number for this approval label (paper insert label) and it is normally located in the lower right corner of the label. **Part numbers that are found in the rows of the non-CBRN approvals must not be used as part of a CBRN SCBA assembly.** Some manufacturers separate all the CBRN part numbers on a given matrix and others do not. **If the non-CBRN part numbers and the CBRN part numbers are inadvertently mixed and attached to SCBA hardware, the use of incorrect parts may cause death or injury.** Administratively and legally, this action voids the NIOSH original approval for that TC number. Many emergency responders may not actually ever see the NIOSH approval label that comes with the CBRN SCBA due to oversight or misplacement of the insert. See Appendix C for an example of a paper insert NIOSH CBRN approval label. Proper documentation of the NIOSH-approved CBRN SCBA will contribute to sound fiscal policies in the jurisdiction of authority.

Digital image to be inserted

Figure XX. Actual Back Frame Assembly with CDC and NIOSH CBRN Agent Approved Label, NIOSH Abbreviated Harness Sticker Label and SEI Compliance Sticker Label Shown. All three labels are required for CBRN compliance.

NIOSH CBRN SCBA USER'S INSTRUCTIONS (UI)

The paper user's operations manual currently does not indicate the part number assigned for the approved user instructions published with the SCBA product. User's instructions specific to each CBRN SCBA are developed by the manufacturer for each unique model, reviewed by NIOSH for clarity, added to the final electronic assembly matrix, but are not necessarily listed on the inserted paper approval label found in the user's instructions. Those manufacturers's user's instructions describe procedures, such as, but not limited to, donning, fit, unit assembly, pre-checks for leakage, breathing air cylinder inspection and exchange, doffing, maintenance, cleaning, storage, and preparation for disposal. In all cases, the manufacturer's user's instructions should be followed in accordance with local OSHA requirements and lead federal agency jurisdiction protocol.

NIOSH CBRN CAUTIONS AND LIMITATIONS PARAGRAPHS 2 AND 3

The subscript 2 and 3 refer to specific paragraphs on the NIOSH CBRN SCBA approval label. Subscript 2 refers to the traditional NIOSH Cautions and Limitations associated with an industrial approved SCBA. Subscript 3 refers to special CBRN Cautions and Limitations applicable to the use of the SCBA under CBRN contamination. **In all cases, all cautions and limitations must be strictly followed. Cautions and limitations I, J, M, N, O and S apply when non-CBRN conditions of use are present. Cautions and limitations Q, R, T and U are additionally applied to I, J, M, N, O and S when CBRN conditions are expected, known or being decontaminated.**

NIOSH APPROVAL LIFE

The life of a NIOSH CBRN SCBA approval does not expire unless the production of the CBRN SCBA is suspended and the manufacturer notifies NIOSH that the product has been discontinued. NIOSH then performs a controlled quality assurance action and physically deletes and renders obsolete from NIOSH records all relevant part numbers identified by the manufacturer. The approval number for the obsolete respirator system still remains in the NIOSH database but the obsolete parts are no longer part of approved assembly matrices used for formal issuance of NIOSH approval letters.

NFPA 1981 EDITION AT TIME OF APPROVAL

CBRN SCBA must meet a compliance evaluation of the current edition of NFPA 1981 for *Open Circuit Self-Contained Breathing Apparatus for Fire and Emergency Services, Edition 2002* both before and after special CBRN tests. The NFPA 1981 standard contains critical SCBA performance requirements unique to firefighting and operations in hazardous environments. *NFPA 1981* is the nationally recognized standard for SCBA equipment used by the U.S. Fire Service. The enhanced performance requirements of the NFPA 1981 standard include higher minimum flow rates and improved breathing resistance. NFPA 1981 testing simulates SCBA use conditions through environmental exposures, including high and low temperature conditions, heat and flame exposure, accelerated corrosion, particulate exposure, and vibration. Lens abrasion and communications (i.e., speech intelligibility while wearing the SCBA) are additionally evaluated. Carbon dioxide levels are also evaluated by NFPA 1981, 2002 edition, and the use of nose cups in SCBA is an end result of showing compliance to the 2002 edition.

Digital image to be inserted

Figure XX . Cylinder Neck Valve Assemblies, minus Cylinders, in Preparation for CBRN SCBA (NFPA 1981, 2002) Upgrade Kit Application Processing. Battery is for PASS device.

CBRN SCBA RETROFIT/UPGRADE KITS

On March 11, 2003, NIOSH began accepting extension approval applications for the evaluation of components and procedures to upgrade previously deployed (field-deployed) NIOSH-approved self-contained breathing apparatus to CBRN-approved configurations. The purpose of the program is to test and evaluate retrofit kits used to upgrade field-deployed SCBA, to assure that upgraded SCBA comply with approved CBRN SCBA configurations, and to assure that the quality of the components and procedures used to upgrade previous versions of the SCBA establish the true CBRN-approved configuration. In addition to the NIOSH CBRN Agent Approved label, CBRN SCBA retrofit upgrade kits contain the replacement components, parts, materials, and operating instructions required to upgrade an existing SCBA configuration to the approved CBRN configuration.

The manufacturer's instruction manuals will provide a list of these components, and the retrofit application will contain the following:

- The minimum technician qualifications for performing the retrofit, and the level of manufacturer training required
- A list of SCBA types certified for use with the CBRN approved retrofit kit
- Identification of the requirements for inspection and operational tests of the SCBA prior to performing the retrofit are required to verify that the SCBA complies with manufacturer quality and performance specifications for SCBA eligible to be retrofitted
- Detailed procedures for replacing components, parts, and materials required to establish the CBRN SCBA configuration

- Guidance concerning the CBRN SCBA operating instructions and differences from normal SCBA operating instructions
- Post retrofit inspections and tests required to verify that the work has been performed properly and that the CBRN SCBA operates in accordance with NIOSH, NFPA, and manufacturer requirements. As a minimum, the post retrofit inspection and test must verify leak tightness of assembly and components, positive pressure (static face-piece pressure), exhalation resistance, by-pass function, remaining service life alarm operation, pressure gauge accuracy, and flow performance.
- Directions for installation of the NIOSH CBRN SCBA Retrofit Approval label

CBRN SCBA agent approved retrofit kits will contain a NIOSH CBRN Agent Approved (retrofit) label that must be affixed to the respirator after the upgrade is completed and the unit has passed the required post retrofit inspections and tests. Only if an SCBA retrofit kit is CBRN approved by NIOSH, will it be identified with a "NIOSH CBRN Agent Approved Retrofit" label. If the NIOSH CBRN Agent Approved Retrofit label is not present, the retrofit kit is not approved by NIOSH for use by emergency responders in CBRN environments.

Check the NIOSH CBRN agent approved retrofit label to alleviate use errors!

Digital image to be inserted

Figure XX. NIOSH SCBA CBRN agent approved RETROFIT Adhesive Label.

Chapter 3: PRODUCTION MODEL SAFETY MARKINGS

UNIQUE CBRN MARKINGS

CBRN SCBA may have unique markings for individual production models which are designed by the manufacturer. These unique markings, if present, are not required for NIOSH CBRN SCBA approval, but rather are present for the benefit of the user to ensure that CBRN tested components are installed on the CBRN SCBA or that CBRN SCBA are easily identified in the field when used or stored along side non-CBRN approved SCBA.

Some examples of these markings are significantly re-designed facepieces, color-coded adhesive labels on the regulator, or other components of the SCBA with printed letters *CBRN* on them. Some components may be embossed with the letters *CBRN* graphically printed. Other components may have the letters *CBRN* etched in specific visible components of the SCBA. The creation of next generation in-use service life concepts that show the amount and location of CBRN contamination on a CBRN SCBA, and perhaps the supporting protective ensemble equipment as well may provide progressive engineering design improvements in this arena.

UNIQUE ADMINISTRATIVE LABELS

CBRN SCBA have unique administrative labels provided by the manufacturer on the SCBA or in various forms of literature that accompany the SCBA. These unique labels provide written warnings, cautions, and informational statements on such topics that include, but are not limited to:

- Indications of damage which would require a cylinder to be removed from service
- Training requirements for use
- Inspection
- Maintenance
- Cylinder storage pressure, if the SCBA is out of service
- Recharging (filling) instructions
- Approved state of use only when compressed air reservoir is fully charged with air meeting the requirements of the Compressed Gas Association specification G-7.1 for Type 1, Grade D air, or equivalent specifications
- Use of adequate skin protection when worn in gas or vapor environments that poison by dermal exposure
- In making renewals and repairs, parts identical with those furnished by the manufacturer under the pertinent approval shall be maintained
- Cautions to open valve slowly and to close valve after each use and when "out of air"
- Cylinders should never be allowed to be completely empty

Cautions and Limitations, Paragraph 2

The following NIOSH industrial cautions and limitations appear in Section 2 of the approval label paper insert and are identified with a superscript [2] on the paper label.

I Contains electrical parts, which have not been evaluated as an ignition source in flammable or explosive atmospheres by MSHA/NIOSH.

Note: *Caution and Limitation **'I'** will not be present on units which have met these evaluation requirements by MSHA/NIOSH.*

J Failure to properly use and maintain this product could result in injury or death.

M All approved respirators shall be selected, fitted, used, and maintained in accordance with MSHA, OSHA, and other applicable regulations.

N Never substitute, modify, add, or omit parts. Use only exact replacement parts in the configuration as specified by the manufacturer.

O Refer to user's instructions, and/or maintenance manuals for information on use and maintenance of these respirators.

S Special or critical user's instructions and/or specific limitations apply. Refer to user's instructions before donning.
Note: *Caution and Limitation **'S'** will only be on the NIOSH approval label if specified by the manufacturer in the user's instructions. When 'S' appears on the NIOSH approval label, the corresponding Cautions and Limitations, that apply under 'S', will be explained in a designated section of the manufacturer's User's instructions (UI)*

Cautions and Limitations, Paragraph 3

The following NIOSH cautions and limitations appear in Section 3 of the NIOSH approval label and apply specifically to use in CBRN environments. Cautions and limitations "**T**" and "**U**" deal with the limitations of use life in confirmed chemical warfare agent environments and determine the CRUL.

Q Use in conjunction with personal protective ensembles that provide appropriate levels of protection against dermal hazards

R Some CBRN agents may not present immediate effects from exposure, but can result in delayed impairment, illness, or death

T Direct contact with CBRN agents requires proper handling of the SCBA after each use and between multiple entries during the same use. Decontamination and disposal procedures must be followed. If contaminated with liquid chemical warfare agents, dispose of the SCBA after decontamination

- The respirator should not be used beyond 6 hours after initial exposure to chemical warfare agents to avoid possibility of agent permeation

MANUFACTURER'S WARNING AND CAUTION STATEMENTS

The manufacturer's UI for each new production SCBA model may specify unique warning and caution statements specific to each model or type and its unique manufactured design. Examples of such statements are instructions related to "hatch air-way" type second stage regulators or "manual slide" or "push-in" type second stage regulators. The respirator training program should include instruction on understanding concerning the manufacturer specific warning and caution statements.

SAFETY DEFAULT TO MANUFACTURER'S USER'S INSTRUCTIONS

The manufacturer's UI are specific for each CBRN SCBA production model. Users should rely on the OSHA regulations with NIOSH recommendations and the manufacturer's UI as the best source of safety and use information for their CBRN SCBA. Users should also contact the manufacturer with specific questions if their concerns are not addressed in the UI or situations involving use are not addressed as noted in training or actual response.

INDICATORS OF CHEMICAL AGENT PENETRATION

Specific chemical warfare agents, particularly HD, have the ability to cause catastrophic material failure of components and accessories, which could cause injury or death to the user. Many CBRN SCBA components and accessories incorporate state-of-the-art hardened polymer material to protect against the aggressive nature of chemical warfare agents. CBRN SCBA has met laboratory test criteria measuring penetration resistance against chemical warfare agents GB and HD. However, it remains important for users to be aware of indicators of material failure of components and accessories in the unexpected event catastrophic material failure does occur. Laboratory testing has demonstrated that in industrial rated SCBA, GB seeks out crevices and dead space cavities penetrating non-hardened surface interfaces or air pressure boundary materials such as silicone. HD has been shown to be an aggressive permeating compound and attacks specific plastic components of any exposed surface of the SCBA. Exposed components on facepieces that are under mechanical stress due to tension or internal valve or spring pressure are particularly vulnerable. Liquid HD, if allowed to stay on a flat material plastic surface, can create grazing of the surface and may contribute to seal degradation. HD can cause brittleness and cracking to untreated polypropylene facepiece material or harness material. Users should inspect their CBRN SCBA when in a safe location and use safe handling procedures to detect signs of material cracking, tearing, and component separation, which could be caused from chemical warfare agent exposure. The traditional two man buddy system or rule is also recommended to all emergency responders to assist in determining potential or actual visible indicators of CBRN agent effects on exposed surfaces of CBRN SCBA.

Indicators of agent penetration and permeation are quantified at the NIOSH level by certification graphs and data sheets assigned to a NIOSH task number. NIOSH live agent test results shown below are examples of quantitative test result indicators that graphically depict maximum peak values and "Concentration over Time" (Ct) values used in determining pass/fail criteria for issuing a NIOSH-approval letter that grants CBRN protection to a SCBA type. The first graph (Figure 8) is a max peak graph and the second graph (Figure 9) is

a Ct graph. Both are required for each agent trial conducted on a SCBA. The max peak LAT graph shows GB pentetration and continues to stay in the breathing zone of the SMARTMAN mannequin for the duration of the six-hour test.

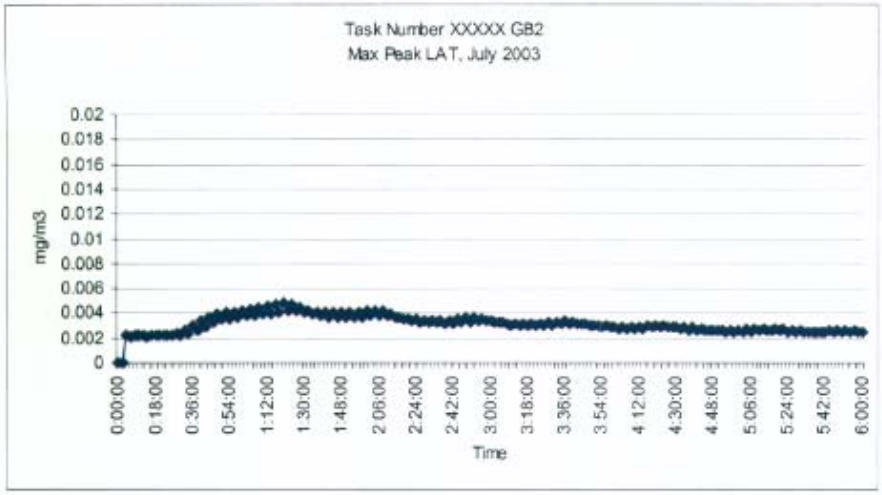


Table XX, Max Peak GB Live Agent Test Result for Certification Task Number XXXX

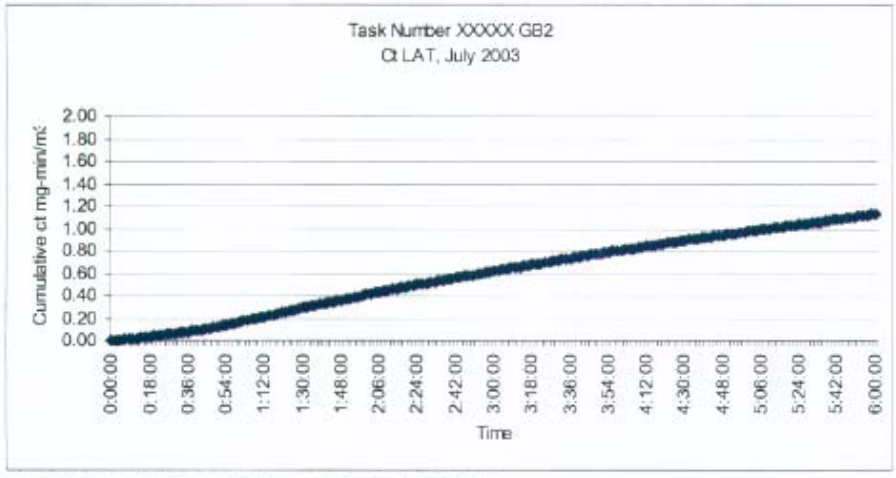


Table XX, CT LAT test result for certification TN XXXX.

CBRN RESPIRATOR USE LIFE (CRUL)

A NIOSH CBRN SCBA has a six-hour (6) use life when exposed to chemical warfare agents. NIOSH NPPTL defines CBRN respirator life (CRUL) as "*a time value in hours or minutes, distinct for that specific type of CBRN respirator.*" The understanding and implementation of this time value is contingent upon the user understanding and adhering to NIOSH approved cautions and limitations issued at the time of the CBRN respirator approval. The use life time value incorporates a continuous use life beginning at the time of confirmed chemical warfare agent exposure. This time **does not include** a variable time value that will be incurred as a result of decontaminating and disposing the CBRN respirator after its use life has expired. The use life concept is centered on a specific time value (X hours) generated from scientific data that repeatedly

shows passing test criteria and results for the safe operation of the SCBA under strict laboratory exposures against GB (Sarin) and HD(Blister) chemical warfare agents at the specified NIOSH standard test procedure time requirement. CBRN respirator use life definition does not apply to respirator exposures against compounds or particulates that currently have NIOSH technical service life guidance in place, such as airborne particulates, provided the exposures do not degrade the air-pressure boundary or cause material surfaces of the CBR N SCBA to catastrophically destruct. If the unknown concentrations do cause the CBRN SCBA air-pressure boundaries or material surfaces to fail, the responder should egress to cleaner air, decontaminate, and doff the respirator per standard operation procedures. The implementation of a CRUL value is not applicable in this case and the destroyed respirator should be replaced, decontaminated and disposed.

Confirmed CWA contamination presence is the key to determining the CBRN SCBA 6-hour start point of contamination. Therefore, instruments designed to detect contamination at stated concentration levels are required to be at the incident site. Once detection confirms the agent type and quantity present, the CBRN SCBA use life of six hours begins.

NOTE: **The six-hour use life means use is for six continuous elapsed hours in a single shift, day, or event. It does not mean six individual one-hour exposures in one shift or one day, nor does it mean six-different one-hour exposures, over the course of six different days.**

Chapter 4: CBRN RESPIRATOR USE LIFE (CRUL) TIME VALUES

Occupational safety and health requirements for emergency responders exposed to CBRN agents are expected to vary depending on several tangible factors. However, these factors have one dimension in common: They are all related around the factor of available **time.** The ten time tangible factors are as follows:

- **Type of CBRN weapon employed**: Employed as or in aerial spray, bomblets, liter containers, 55 gallon drums, postal envelopes, packaged boxes, rail line conex dispersion, bulk food containers, vehicle borne improvised explosive devices, satchel improvised chemical devices, or as multiple types of agents simultaneously or sequentially deployed.
- **Weather conditions and target geography at time of employment**: Variable factors such as changing air stability categories, before-morning-nautical-twilight weather conditions (BMNT), early-evening-nautical-twilight conditions (EENT), temperature gradients in air strata, wind speed at the surface and above ground, wind direction, daylight hours, nighttime hours, confined spaces, subterranean spaces, and urban, forested, inland or coastal regions.
- **Density of structures in targeted areas**: Channeling effects of downwind hazard, open terrain, urban terrain, no structures, minimal structures, congested structures, low profile structures, high profile structures, evacuation routes in place, and shelter in place actions rehearsed and available to the public
- **Construction integrity of targeted structures**: Soft target, hard target, reinforced concrete command post, public restaurant, public venue, public transportation, mobile target, and static target
- **Concentration of CBRN agents deployed**: Low level dispersion devices, high yield dispersion devices, liquid pools, dissipating vapors, vapor density, physical constants of agents, and multiple targets
- **In place and adequate sampling and detection plans:** Remote sensing devices, on-site detection devices, chain of custody of samples, public health laboratory capacities, and federal laboratory turn around capabilities
- **PPE:** Selection, availability, serviceability and interchangeability of personal protective equipment
- **Training**: Psychological preparation, PPE training levels and PPE acclimatization of responders
- **Command and Control:** Timely characterization of the crime/accident scene, size up, scene control, stages of response
- **Site Security**: Timely mitigation, containment or disarmament of any secondary or tertiary CBRN device, evidence preservation, security of the scene, weapon/improvised device location, and robotics

All of these factors have one concept in common: TIME. Whether it is CBRN agent employment time, responder response time, available responder rescue time, responder air cylinder service time, or responder egress and recovery time, time management principles play a critical role. Time management principles that currently exist for CBRN SCBA consist of three time concepts. They are service life (time), rated service time, and CBRN respirator use life (time).

SERVICE LIFE OF CBRN SCBA AND COMPONENTS

The definition of service life has precedence. A NIOSH definition of 'Service Life' for a SCBA is the "*period of time, as determined by NIOSH certification tests, in which adequate breathing gas is supplied.*" [DHHS (NIOSH) Pub No. 2005-100. 2004] This same definition applies to the 42 CFR 84 use of the terms 'rated service time' or "service time" [42 CFR 84, Para 84.70, (a), (b), (2) (ii), Para 84.95, (a), (b), (c) and Para 84.53, (a), (b).1995].

For the purposes of CBRN SCBA, service life or time is still the same industrial definition with enhanced tactical use requirements. This inference is situation dependent but may refer to the length of time the system as a whole or its individual components (for example, facepiece, harness assembly, or regulators) are expected to remain functional based on time of use, exposure duration, exposure type, or number of uses. If the SCBA is exposed to vapor or liquid chemical warfare agents, the interim guidance related to CBRN Respirator Use Life (CRUL) applies.

The SCBA manufacturer may specify service life information for the system as a whole or for particular components in the manufacturer's UI; however, industrial service life/time is commonly understood to be the 60, 45, 30 minute duration at specified pressure ranges. When specific service life information related to CBRN use or traditional industrial/fire use is available from the manufacturer, it should be followed. To ensure all components are functional and free from damage and excess wear, an inspection of all SCBA components should be performed prior to the beginning of each shift or as the end user deems appropriate and in accordance with the manufacturer UI. In making renewals and repairs, parts identical with those furnished by the manufacturer under the pertinent approval, shall be maintained.

Service Life of Air Cylinder

The service life of an air cylinder is the length of time the cylinder can remain functional before it must be removed from service and permanently retired. All manufacturers' guidance on cylinder service life is provided in the manufacturer's UI or available from the cylinder manufacturer. All information must be adhered to.

The U.S. Department of Transportation (DOT) Title 49 specifies regulations for marking, hydrostatic testing at the time of manufacture, and re-qualification of cylinders at specific time intervals depending on the design type of the cylinder. Requalification of cylinders can only be legally performed at retest facilities that have been issued retest identification numbers by DOT. The re-qualification of cylinders requires an internal and visual inspection, a hydrostatic test, marking or labeling, and maintenance of proper records of the re-qualification.

Re-qualification of SCBA cylinders is required with a pre-determined frequency, depending on the design type of cylinder. Generally, composite cylinders, or those having a metal core wrapped in non-metal materials such as Kevlar or fiberglass composites, are re-qualified every three years and all-metal cylinders are re-qualified every five years. The manufacturer or cylinder owner and retest facility are required by DOT to know how often to have the re-qualification performed. DOT-compliant, carbon composite cylinders have a maximum service life of about 15 years, as specified by the exemption issued to the cylinder, and are to be re-qualified every five years, as specified by the DOT exemption issued to the cylinder manufacturer. The

service life of all-metal cylinders is determined at the time of re-qualification. If the cylinder passes the re-qualification, it can be used until the cylinder shows external damage, its next re-qualification or its end of service life. Select cylinder manufacturers that have longer than 15 year service life exemptions, such as 30-year, for carbon composite cylinders, should be contacted for relevant information regarding re-qualification.

Before each use of the respirator, the hydrostatic test date on the cylinder should be checked to ensure that it is current. Cylinders which are past due for DOT re-qualification should be immediately removed from service until they are re-qualified or have reached the end of their service life.

Damage and wear of cylinder components will affect cylinder service life. The cylinder assembly (cylinder, gauge, and valve) should be inspected before each use to ensure that it is functional. The NFPA 1852 *Standard on Selection, Care and Maintenance of Open-Circuit Self-Contained Breathing Apparatus (SCBA)*, 2002 Edition, contains recommended NFPA procedures for SCBA cylinder maintenance.

Cylinders should be examined for damage and wear before each use. Damaged cylinders must be immediately removed from service until adequately repaired. Signs of wear or damage which can affect service life are cylinder color change, burns, blistering, and deformities in the shape of the cylinder such as cracks, dents, weakened areas, and surface indications of penetrating chemical damage. Additionally, the manual rolling of cylinders on the floor to check for uniform cylindrical shape is a common practice in the fire fighter workplace [Email, Fire Department New York, 2004].

The criteria for conducting a visual inspection of the cylinders, including quantification of surface damage, are available upon request directly from the cylinder manufacturer or the SCBA manufacturer.

The respirator manufacturer can provide specific guidance on reading and interpreting DOT markings on cylinders and how the hydrostatic test date markings are updated when a cylinder is re-qualified. Among DOT marking requirements which users should be familiar with are the following three items:

- **Hydrostatic Test Date**
  The hydrostatic test date is the date the cylinder was hydrostatically tested and considered qualified for use. DOT also specifies regulations for the periodic re-qualification of cylinders. The hydrostatic test dates appear on each cylinder in compliance with applicable DOT regulations. It is generally a month, a certification unique inspection symbol and a calendar year, i.e. 7^05, along with the issued RIN.

- **Cylinder Pressure Rating**
  Cylinder pressure rating is specified by the manufacturer to be either 4500 psig, 3000 psig or 2216 psig. The cylinder pressure rating on the cylinder must be checked against the manufacturer's UI and the SCBA in use, to ensure it is compatible with the SCBA system. Under certain OSHA provisions interchangeability between similar pressure ratings but different SCBA manufacturer's air cylinders is possible on the incident scene. For further information concerning OSHA interchangeability of SCBA cylinders go to:
  http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=23479

- **DOT Exemption Number, Composite Cylinders/Specification Number, All-Metal**
  DOT exemption number or specification number corresponds to specific DOT regulations for cylinders, including retests and service life. All retesters, cylinder owners, and inspectors should be aware of any and all retest requirements and service life requirements pertaining to cylinders they handle.

Service Life of Facepiece

All manufacturers' guidance on criteria for facepiece service life must be followed. The facepiece should be inspected before each use to ensure that it is functional.

Facepiece service life is affected by time, exposure event, operator maintenance, and number of uses. The elastomeric material of the facepiece must remain pliable to provide the best seal to the interface between the material and the pliable surfaces of the human face. Elastomeric materials of facepieces can become cracked, frayed, and lose elasticity over time. Cracks, tears, holes, or distortions of the facepiece may result from routine use or improper storage. Headstraps and head harness components should be replaced when broken, when elasticity is lost or diminished, or when excessively worn serrations on the head harness that permit slippage. Broken and malfunctioning buckles should be replaced. Facepieces with cracked or badly scratched lens should be removed from service and repaired or disposed of properly.

Other components or accessories found on the facepiece which may need to be replaced or repaired are hydration devices, spectacle (glasses) inserts, heads-up-display systems, speech diaphragms, and communication devices which electronically amplify the speaker's voice or send electrical sound transmissions. Hydration devices, also known as drink tubes, are not NIOSH-approved for CBRN SCBA or traditional SCBA. Next generation CBRN SCBA may incorporate hydration, ESLI, protective suit interfaces and other assorted technology enhancements.

Service Life of Remaining SCBA Hardware

Remaining SCBA components which must be inspected prior to each use are the backframe and harness assembly, hoses, end of service time indicators (EOSTI), regulators, and system accessories. Damaged or malfunctioning hardware should be repaired or replaced by qualified personnel prior to use. The SCBA manufacturer may specify service life information for particular components in the manufacturer's UI. When this information is available from the manufacturer, it should be followed.

Rated Service Time Indicators

CBRN SCBA contains all the traditional NFPA compliant rated service time indicators and displays. The following three are the most prominent types:

- Heads-Up Display
- Pressure Gauges
- End of Service Time Indicators

CRUL: NIOSH CBRN RESPIRATOR USE LIFE (CRUL) CAUTIONS AND LIMITATIONS RELATING TO CHEMICAL WARFARE AGENT EXPOSURE

NIOSH CBRN Caution and Limitation 'U' listed on the NIOSH approval label contained in the manufacturer's user's instructions states:

U- "The respirator should not be used beyond six (6) hours after initial exposure to chemical warfare agents to avoid possibility of agent permeation."
This statement means that following use in an environment which contains confirmed chemical warfare agents, in liquid or vapor form, the NIOSH-approved CBRN SCBA must be removed from service and disposed of following 6 continuous hours of use after the initial confirmed exposure. The SCBA should not be reused and should be decontaminated and disposed of in a manner that is consistent with the type of contamination and any local, manufacturer recommended, or government regulations governing the decontamination and disposal of CBRN contaminated items.

Confirmed CWA contamination presence is the key to determining the 6-hour start point of contamination of a CBRN SCBA. Therefore, instruments designed to detect contamination at stated concentration levels are required to be on the incident site. Once detection confirms the agent type and quantity present, the CBRN SCBA use life of 6-hours starts. The CRUL six-hour time value means **six continuous hours** in a single shift, day, or event. It does not mean 6-individual one-hour exposures in one shift or one day, nor does it mean six different one hour exposures over the course of six different days. Six continuous hours stop at the 5-hour, 59-minute and 60-second mark.

Respirator use beyond the 6-hour mark of continuous use in a confirmed chemical warfare agent (CWA) incident goes against the NIOSH Caution and Limitation "U." However, in actual use the incident commander at the scene of a CWA incident may be confronted with the decision to implement use beyond the 6- hour mark. For example, the need to rescue and recover victims, combined with a supply shortage of new CBRN SCBA units at the scene, could present such a need. Use of a contaminated CBRN SCBA beyond the 6-hour mark may put responders at risk to possible exposure of CBRN agent, which could permeate the contaminated CBRN SCBA. The incident commander must determine at the six-hour mark if the possibility of agent permeation has been negated by immediate gross decontamination techniques.

Responders must also be aware of the possibility of indirect contamination by liquid or vapor CWAs which are also considered in the 6-hour use life rule. Indirect contamination may occur, for example, when CBRN SCBA are used in downwind areas from the response site or a liquid CWA contacts a unit through direct or indirect contact with other responders, victims, or equipment outside of the target area. **The six-hour use life rule should be obeyed even if the SCBA is contaminated indirectly.** However, the incident commander may determine, based on the type and concentration of CWA exposure and immediate technical decontamination techniques, that modification to the 6-hour use life rule is possible.

NIOSH CBRN caution and limitation 'T' listed on the NIOSH approval label contained in the manufacturer's user's instructions states

T - "Direct contact with CBRN agents require proper handling of the SCBA after each use and between multiple entries during the same use. Decontamination and disposal procedures must be followed. If contaminated with liquid chemical warfare agents, dispose of the SCBA after decontamination."

In relation to the 6-hour use life, this limitation states that if contaminated by a liquid chemical warfare agent, the SCBA should be disposed of after decontamination. The limitation warns against reuse after a liquid exposure due to the persistency of some CWA liquids; for example, HD is highly persistent as a liquid. In the case of a CWA liquid exposure, use beyond the 6-hour limit is highly cautioned against even when rapid technical decontamination can be performed. Decontamination should be performed in all cases for all confirmed CWA exposures, even if the agent is considered non-persistent as a vapor (such as GB). Even non-persistent CWA vapors can permeate and remain in materials if exposure concentrations are high, such as in a confined space. CWAs can also become airborne in the form of liquid aerosols, which are small liquid particles and not in true vapor states.

NIOSH Interim Recommendations for Firefighters and Other First Responders for the Selection and Use of Protective Clothing and Respirators Against Biological Agents, DHHS (NIOSH) publication number 2002-109, states ***decontamination of protective equipment and clothing is an important precaution to make sure that any particles or contamination that might have settled on the outside of protective equipment are removed before taking off gear. Decontamination sequences currently used by hazardous materials teams should be appropriate for the level of protection employed. Equipment can be decontaminated using soap and water as part of a removal process, and 0.5% hypochlorite solution (one part household bleach to 10-parts clean water) can be used as appropriate and if gear has any visible CBRN contamination. Note that bleach may damage some types of equipment. After doffing all PPE, emergency response workers should shower in safe non-contaminated area using copious quantities of soap.***

RATIONALE FOR CBRN RESPIRATOR USE LIFE (CRUL) SCBA CAUTIONS AND LIMITATIONS

CBRN SCBA with confirmed chemical warfare agent contamination may not provide their intended full level of protection to users if used beyond the NIOSH six-hour recommended use-life limitation. The rationale for the six-hour use life limitation was developed from laboratory tests evaluating penetration and permeation resistance of complete dynamically operating CBRN SCBA systems to GB vapor and HD vapor and direct contact with HD liquid droplets. The six hours of testing require the SCBA to be refreshed with clean air essentially five times over the time of one test trial. This means that an air cylinder may be replenished more than once in the use life of a CBRN SCBA respirator.

NIOSH testing utilizes a mechanical breathing pump attached to a zinc manikin head-form called a SMARTMAN (**SiMu**lant **A**gent **R**esistant **T**est **Man**ikin). The SMARTMAN headform has a respirator facepiece donned and tightened per the UI while remaining hardware is operational inside a confined space exposure chamber. The air cylinder is not present during this SCBA systems test, only the cylinder neck valve assembly and a tooled adapter torqued to a pressurized air source line, is used.

For primary testing criteria, acute exposure guideline (AEGL) Level 2, at the one hour level, is used as the maximum breakthrough period. In addition, to verify that potentially high brief 'detection peaks' do not

exceed requirements, peak concentrations identified in the test results are also evaluated against AEGL Level 2, 10-minute levels. For example, peak concentrations as measured in the test protocol, do not exceed the higher 10-minute level [Niemeier, Richard, 2001]. AEGL are established by a National Advisory Committee for the Environmental Protection Agency and the National Research Council. They represent threshold emergency exposure limits for the general population, including more susceptible portions of the population, and are applicable to emergency planning and decision making. The AEGL values are agreed upon by the public, other NIOSH scientists, DoD scientists and members of the National Academy of Sciences through a process of rigorous scientific discussion, consensus, and subsequent review in a transparent process.

AEGLs address various degrees of the severity of toxic effects that are represented by AEGL 1, 2 and 3. Each of these levels represents the lowest estimate of a concentration above which a specified effect might be observed in an exposed population. AEGL-Level 2 values are the most appropriate threshold exposure limit (breakthrough) values for GB and HD testing since they ensure no significant respiratory impairment or long-lasting effects will result if approved systems are properly worn [Niemeier, Richard, 2001]. NIOSH NPPTL adopted these values in defining the performance standard for the CBRN SCBA.

The duration of each agent test is six hours. NIOSH uses six hours because the most credible event was determined by a joint NIOSH/RDECOM threat analysis and is based, not on a worst case threat, but on a "most likely to occur" terrorist threat concentration gradient. Toxicological analysis is used to define the required level of protection the SCBA must be capable of providing. The six hours consist of 30-minutes of actual agent exposure followed by 5.5 hours of natural decay. Due to the time-limit capacity of SCBA air cylinders, less than one hour, or approximately 30 to 45 minutes, depending on the physiology and work rate of the wearer, the overall one-time exposure of personnel and SCBA equipment also is expected to be less than one hour. However, responses at the Pentagon site in 2001 showed the same SCBA being used with the same or different cylinder for upwards of 12 hours per terrorism response shift [Arlington County After Action Report (AAR), July 2002]. SCBA were in short supply and responders going off shift did not want to surrender their SCBA to oncoming responders due to the shortage of SCBA and possible concerns over communicable health diseases. Air supply sources were in short supply and responders had to spend time looking for air replenishment sources. The use of quick charge and other methods for cylinder air replenishment were employed [Arlington County AAR, 2001]. These examples show how the same SCBA can be used for a longer duration than anticipated.

The NIOSH goal was to identify existing SCBA respirators that can ensure that overall physical and chemical protection is maximized. A six-hour CRUL time value has achieved that initial goal. Only actual response(s) to a CBRN incident will determine if the CRUL time value(s) are adequate.

Both GB and HD are considered to be extremely hazardous agents given their extreme toxicity compared to industrial chemicals, their permeation and penetration characteristics, their relative ease to produce and their worldwide availability in thousands of metric tons. The test parameters for the HD test are the application of a maximum of 43, 20-ul liquid droplets initially and then left undisturbed for the entire 360-minute (6-hour) test duration followed by an HD agent vapor concentration of 300 mg/m^3 generated during the initial 30 minutes of the six-hour test. HD was selected because of its permeation characteristics. HD is a linear molecule that permeates surfaces over time and interacts at the molecular level to stay bonded to the material. Ideally suited to contaminate terrain, equipment, and cause delayed but prolonged affects on personnel, HD is considered to be a persistent classic chemical warfare agent by the U.S. military.

The test parameters for the GB test are 2,000 mg/m3 of vapor/aerosol generated for the initial 30 minutes of the six-hour test. GB was selected because it is the most volatile of the nerve agents, having a volatility of 22,000 mg/m^3 and has low molecular weight and molecular branched configuration (approximately 108 angstroms in length), enabling it to permeate through SCBA materials more readily than other G series or V series nerve agents. Scientific studies on dogs and rats indicate that exposures to 0.001mg GB/ m^3 for up to six hours per day are unlikely to produce any signs of toxicity. Recent news articles regarding human test subjects exposed to nerve agents in the United Kingdom are just now surfacing in the international public media [XXXX]. GB is representative of nerve agents. Other nerve agents include GA (Tabun), GD (Soman) and VX. GB molecular configuration of approximately 108 angstroms enables it to penetrate surface interfaces, seams, openings, crevices, overlaps, or dead spaces of SCBA materials. A liquid GB droplet test is not performed by NIOSH since GB is understood to be the most significant threat when aerosolized in aerial vapor dispersion rather than in a liquid droplet state. GB liquid evaporates at a rate similar to water and therefore presents a non-persistent, but highly toxic hazard, which in a confined space requires both dermal and respiratory personal protection. Therefore, the GB vapor adsorbed on the surface of the SCBA is also a dual source of agent exposure from penetration or permeation generated in the NIOSH NPPTL certification tests.

A combination liquid-vapor test is used for the HD tests, wherein liquid droplets of HD are placed on selected areas of the SCBA and a vapor challenge of HD is also introduced into the test chamber. The liquid droplets and vapor test the permeation resistance of the respirator materials and the integrity of the materials to withstand the persistent chemical effects of HD. Since the permeation effects of HD are essentially non-reversible, HD contamination remains at the molecular level and decontamination laboratory operations prove that high temperature water baths force HD out of material surfaces but do not force out all of the HD over a given period of reasonable water bath boiling exposures (4 hours to upwards of 72 hours or greater). Once a material exposed to a chemical warfare agent is decontaminated to what is termed the 'XXX' level, it is acceptable for processing and incineration as a hazardous waste at a waste site collection point [RDECOM Protective Equipment Team IOP No. 12, March 2004].

Digital image to be inserted

Figure XX, HD Droplet Pattern on Candidate CBRN SCBA. NIOSH LAT, 2003.

Chapter 5: BEFORE, DURING AND AFTER USE ACTIONS

BEFORE USE OPERATIONS

Shipping

CBRN SCBA should be shipped in the original manufacturer packaging. Routine DOT hazardous material labeling for filled air cylinders is required. Special care should be given to ensure that no excessive abuse of shipped containers occurs. Part numbers on original invoice should match CBRN SCBA part numbers of the shipped order.

Receiving

Upon receiving a new CBRN SCBA, thoroughly check that all components and accessories are included in the shipment, the user's instructions are present, the NIOSH CBRN SCBA adhesive label is on the harness assembly and the NIOSH CBRN SCBA approval label paper insert is present in the UI. Match the individual component part numbers to the numbers listed in the respirator component column of the NIOSH approval label (paper). NFPA 1852 requires baseline posi-check of the SCBA upon receipt. A copy of the manufacturer's posi-check results should be provided with the SCBA. Ensure that you know how to read it and forward any questions or noted errors to the respirator manufacturer.

Inspection, Maintenance and Storage of CBRN SCBA

This section provides guidance for the inspection, maintenance, and storage of CBRN SCBA. Users should **always** follow the manufacturer's suggested practices for inspection, maintenance, and storage of their individual CBRN SCBA model. A recommended reference is NFPA 1852 *Standard on Selection, Care, and Maintenance of Open-Circuit Self-Contained Breathing Apparatus (SCBA),* 2002 *Edition.*

Inspection

General Criteria: It is critical that the user verify that all of the CBRN SCBA components listed on the NIOSH approval label (that is the matrix style paper insert) provided with the user's instructions are present, correctly installed, and free from visible deterioration, wear, and damage. All guidance and recommendations made by the manufacturer should be followed.

Specific Criteria: The following inspection procedures should be performed before each use of the CBRN SCBA. The inspection sequence is per the manufacturer's UI and the listing may not be all inclusive.

Facepiece

- Check the elastomeric material for pliability, damage, tears, and cracks. Ensure no material defects are present.

- Check that all head harness straps are fully extended, functional, elasticity is not lost, buckles properly function, and buckles or straps are not damaged. Ensure the types of head harness, Kevlar or butyl, and the visible part number for the head harness; match the CBRN SCBA label by part number and material, applicable to the NIOSH TC number for CBRN protection. If the part numbers do not match, contact the manufacturer. Ensure that a CBRN part number is used because, if it is not, the same level of CBRN protection determined by the NIOSH CBRN approval will not be attained if a non-CBRN part number is used.

- ***NOTE:*** **If the part number listed on the matrix for CBRN configuration does not match the part number located on the actual part, DO NOT USE THE RESPIRATOR FOR A CBRN RESPONSE.**

- Check the lens for holes, cracks, scratches, heat-damaged areas, and a properly maintained locking ring and seal with the facepiece material

- Check the second stage regulator exhalation holes or valve for debris that, if present, could inhibit proper regulator seating/sealing and locking of the regulator to the facepiece assembly

- Check the regulator connection(s) for damage and proper function

- Check that the Heads-Up-Display, if present, is functioning properly

Backframe

- Check that harness straps and backframe are free from cuts, tears, abrasions, and indications of heat and chemical-related damage. Ensure that the NIOSH CBRN label and harness assembly label are present and readable.

- Buckles and fasteners should be checked for proper adjustment. Fully extend the harness straps

- The cylinder retention system should be checked for damage and proper operation and to ensure that the cylinder is securely attached to the backframe

Cylinder Assembly (cylinder, gauge, and valve)

- Check that the hydrostatic test date on the cylinder is current. Cylinders which are past due for DOT re-qualification should be immediately removed from service until they are re-qualified

- Check the cylinder body for cracks, dents, weakened areas, indications of heat damage, discoloration and indications of chemical damage

- Check the cylinder valve outlet sealing surface and threads for damage, wear and clear any debris found

- Check the valve hand wheel for damage, proper alignment, and secure attachment

- Check the burst disc outlet area for debris. Ensure that they are clear

- Check that the cylinder is fully charged to the manufacturer's specified pressure rating. Air cylinders should be maintained in a fully charged state but should not exceed the manufacturer's maximum

recommended pressure. Air cylinders should be recharged when the pressure falls below one quarter of the manufacturer's recommended full pressure level. Use the local department standard operations procedure (SOP), respirator manufacturers UI, applicable NFPA codes and OSHA regulations.

- If the end user is technically qualified, he or she should ensure that the neck cylinder valve assembly is fully serviceable and shows no bend in the neck valve or probe. Ensure that the burst disc is clean and lubricated per the UI. Ensure that the independent air pressure gauge internal to the neck cylinder valve is readable and showing proper air pressure when correctly torqued into the cylinder. If end user is not technically trained and qualified to conduct these checks, refer these actions to the next higher level of maintenance.
- DO NOT DROP the assembled CBRN SCBA on the high pressure hose coupling adjacent to the neck cylinder valve assembly
- Dropping of the SCBA on other component parts may or may not produce adverse affects on the CBRN SCBA. All maintenance should only be done by a team or individual trained and certified by the CBRN SCBA manufacturer and in accordance with applicable standards such as NFPA 1404 code.

End-of-Service-Time Indicator (EOSTI)

- Check that all EOSTIs function and work in accordance with the manufacturer's instructions
- The inspection should ensure that the alarms function properly by observing visual, audible, or vibrating signals over a period of time as specified in the user's instructions

Regulator

- Check the regulator controls, where present, for proper function. Ensure thatall CBRN markings are readable and that unique CBRN components are in place per the UI.
- Listen for any unusual sounds such as whistling, chattering, clicking, or rattling during operation
- Check that the regulator by-pass functions properly. Use the by-pass and check for correct de-pressurization/bleed down

Pressure Gauge

- Check that pressure gauges are functional and that the cylinder pressure gauge and remote gauges read within 10% of each other. The remote pressure gauge can be a mechanical gauge face or a visual signal continuously displayed as part of a facepiece HUD
- Ensure that any vent holes are free of debris prior to activation

PASS (Personal Alert Safety System) Device

- Check all operating modes for proper function in accordance with the manufacturer's UI

- Ensure batteries are available and installed for operation per UI

Final Pressure Check

- As the final inspection item, the entire CBRN SCBA should be checked for pressure retention. This is accomplished by closing all regulator valves, opening the cylinder valve, thereby pressurizing the CBRN SCBA, and then closing the cylinder valve
- The system should hold pressure in accordance with the manufacturer's specifications after the cylinder valve is closed. Ensure the length of time is as stated in the UI. Reopen the valve and observe gauge changes for proper movement and stability.
- Following the pressure check, the system pressure should be released per the UI

Maintenance

All maintenance, repairs, and replacement of parts on a CBRN SCBA are required to be done by trained and qualified personnel. Following any maintenance procedures, a qualified person should verify that the SCBA has been assembled to the correct NIOSH approved CBRN configuration, which is printed on the NIOSH CBRN SCBA approval label paper insert of the user's instructions. All maintenance is done in accordance with the manufacturer's user's instructions, local departmental SOP and available conversations with the manufacturer's representative.

Storage

- Respirators required to be immediately available should be stored in a ready-to-use condition. This condition is normally manufacturer and departmental specific but overall, it is designed to protect respirators from excessive dust, excessive radiant sunlight, excessive heat transfer, incompatible damaging chemicals, or excessive cold and moisture, and other conditions as specified in the UI.
- Facepieces and second stage regulators should be stored in normal use positions, if possible. Impaired functions of the facepiece or regulator may result if the facepiece elastomer is allowed to sit in an abnormal position, such as inside a turnout gear jacket, wedged in between a seat and seat storage area, stored where the head harness straps are inadvertently placed over the facepiece lens/visor or the facepiece is exposed to the natural elements of weather for an excessive amount of time.
- Respirators not used on a daily basis should still be maintained for immediate use in the event of repsonders replacing a field deployed respirator in accordance with end user standard operating procedures or supplemental instructions. Some user's instructions recommend storing the dried facepiece in clear plastic bags after and placing them bagged in storage cabinets. Contingency stocks stored for long periods in climate controlled facilities or designated logistic warehouses should be inspected regularly in accordance with the CBRN SCBA manufacturer's UI. It is recommended that CBRN SCBA, which are being used as dual-purpose SCBA, (dual-purpose meaning that they are worn for every day use and on order, CBRN response) also be used for any additional training or maintenance prior to actual first time CBRN SCBA use.

- The OSHA Respiratory Protection Standard [29 CFR 1910.134] allows for SCBA to be stored in vehicle compartments or in specific SCBA covers/containers/bags on fire trucks/law enforcement vehicles/ambulances. Brackets that are mounted on a wall or to a stable surface (e.g. on a fire truck) are normally used to store SCBA. The brackets, when properly designed to a specific SCBA, ensure that the SCBA is secured, covered and not subject to being wedged in a constricted space that would likely produce facepiece distortion or airline hose compression.

RESPIRATOR PROGRAM ADMINISTRATOR OR INCIDENT SAFETY OFFICER RESPONSIBILITIES

Protection performance differences between CBRN SCBA and non-CBRN SCBA are significant, depending on the type of particular SCBA used. Respirator protection program administrators, incident safety officers, departmental health and safety officers or other similar duty personnel have unique use challenges when integrating CBRN SCBA into an existing respirator protection program or when starting a new respirator protection program.

While the CBRN SCBA retains many of the same respirator program qualities of the standard non-CBRN SCBA, new "use" challenges exist. They are the implementation of CBRN SCBA in-use service life protocols, integrating CBRN SCBA decontamination operations, understanding CBRN SCBA retrofit/upgrade kit instructions and requirements, and recognizing CBRN SCBA administrative label markings. User level exchange of non-CBRN SCBA and spare cylinders for NIOSH-approved CBRN SCBA and spare cylinders will require initial and refresher training relevant to the new aspects of how a responder department conducts a CBRN agent response.

"Mask division" or "Mask service unit" personnel of fire departments are best suited to fully integrate manufacturer-specific warnings, cautions, and alert messages pertaining to operation and maintenance of CBRN SCBA and upgraded CBRN SCBA. Additionally, local emergency responders may have manufacturer trained and certified technicians that manage SCBA maintenance programs at the law enforcement, emergency medical or hazardous material response levels.

It is likely that in emergency responder departments that replace old SCBA with new CBRN SCBA, both non-CBRN NFPA compliant SCBA and CBRN SCBA will be present for a period of time. In that case and in incident response cases, responders should be thoroughly trained on how to differentiate CBRN SCBA from non-CBRN SCBA. A few recommendations are as follows:

- CBRN approved components can only be used in NIOSH-approved configurations shown in the assembly matrix on the inside page or pages of the specific CBRN SCBA user's instructions
- The NIOSH-approved CBRN SCBA can be used only with a specific type of facepiece model number, for example, a Hycar material model number.

NOTE: Silicone facepieces or components, when used without butyl or Hycar second skin layers, have been shown to contribute to the failure of a respirator during NIOSH CBRN special test requirements.

- The NIOSH-approved CBRN SCBA usually has specific types of second stage air-pressure regulator assemblies. These regulators are part number specific to NIOSH-approved CBRN SCBA. They should not be intermixed with non-CBRN/Industrial or non-CBRN/NFPA compliant SCBA.

TRAINING

Qualified initial and refresher training on all aspects of the proper use, emergency use, use life and disposal of the CBRN SCBA are recommended for all CBRN SCBA end-users.

To attain the proper respirator fit, seal and operational capability, end users should be trained, retrained and confident in using a CBRN SCBA before an actual response event occurs. In a well-defined respirator program users should know the UI thoroughly and practice donning, wearing and removing/doffing the CBRN SCBA to attain and maintain proficiency.

The information in this guide is intended to be administered through a complete respiratory protection program as described in OSHA, 29 CFR 1910.134. A complete respiratory protection program covers criteria for selecting respirators, medical evaluations, fit testing, maintenance, inspection, cleaning, storage, worker training, and frequent evaluation of the effectiveness of the program. The respiratory protection program is to be directed by a designated knowledgeable professional, commonly known as the respirator program officer/administrator (RPO). Incident safety officers (ISO) and health and safety officers (HSO) play key roles in convincing responders that responder safety is a priority on the worksite and that safety awareness and actions can minimize acute and potentially chronic workplace exposures. The respirator program administrator interacts with management and oversees all aspects of the respirator program. The RPO and the ISO/HSO should be available to the user for questions or concerns on respirator use.

The required training under the OSHA Respiratory Protection Standard [29 CFR 1910.134] includes:

- Why the respirator is necessary and how improper fit, usage, or maintenance can compromise the protection of the respirator
- What the limitations and capabilities of the respirator are
- How to use the respirator effectively in emergency situations, including situations in which the respirator malfunctions
- How to inspect, put on and remove, use, and check the face seal of the respirator
- How to recognize medical signs and symptoms that may limit or prevent the effective use of respirators
- Information relating to the OSHA Respiratory Protection Standard [29 CFR 1910.134] is available at the OSHA Respiratory Protection website at: http://www.osha.gov/SLTC/etools/respiratory/index.html

AIR SOURCES

- Compressed air supply sources for CBRN SCBA are identical to non-CBRN/industrial SCBA air sources. The quality of Grade D or higher air generated or stored in a source/vessel requires regular inspection.
- CBRN SCBA requires the same "grade of air" routinely used in fire fighting, law enforcement or industrial/non-CBRN SCBA workplace environments
- During NIOSH CBRN SCBA certification tests, certain SCBA show non-toxic particulates circulating in the air pressure boundary of the tested SCBA. In the course of NIOSH CBRN SCBA TDA-99M testing, CBRN SCBA can have particulates in the exhalation air flow of the operating SCBA. These particulates are thought to be oil, water and other compounds off-gassing from the internal mechanisms of the SCBA. Manufacturers that have high particulate counts are required to provide Material Safety Data Sheets (MSDS) stating what the health impacts are from the off-gassing particulates, prior to receiving a NIOSH-approved letter.
- Before use in a CBRN incident response, air sources should at a minimum be fully compliant with all Compressed Gas Association (CGA) requirements for Grade D air.
- CBRN contamination of air sources during an incident response or attack is best prevented by locating the air sources away from contamination or shielding them in suitable containers/areas. If air sources become contaminated, quantify the contamination to ensure that the air source is contaminated, tag the source and locate/procure uncontaminated air sources for immediate or future operations.

  Note: Do not use an air cylinder that contains, or is suspected of containing contaminated air.
- Compressed 'gas'/air cylinders used with CBRN SCBA are DOT certified and exempted under current DOT provisions for shipment of hazardous cargo.

RECOMMENDED CBRN INCIDENT DETECTION METHODOLOGIES USED BEFORE OPERATIONS

- Emergency responders may train on three types of CBRN incident detection methodologies before actually responding to a CBRN incident. The three types are as follows: training on the types of CBRN qualitative indicators, training on qualitative detection actions/kits and training on sampling and monitoring actions required for formal chain of custody quantitative detection methods.
- Knowing before an incident response that there are certain chemical agent qualitative indicators involved in a response call should increase responder size-up efficiency and add a level of safety awareness that will allow responders and response agencies to perform in a more cohesive manner.
- Examples of chemical agent qualitative indicators are as follows: standing pools of unknown liquid on flora/fauna/manmade surfaces with no odor thresholds or mild odor thresholds/off-gassing; visible colored or gray colored aerosol clouds slowly moving or stagnate in low lying areas; overt visible indicators such as humans or animals in respiratory distress, prostrate humans or animals, or immobile humans or animals

with excessive salivation, bodily excrement or convulsions.

- Examples of chemical agent mild odor threshold smells are as follows: new-mown hay/cut lawn grass, green corn, faintly or overtly fruity smell, camphor, peach kernels, musty, damp dirt or basement smell, sugary sweet, shellac/varnish, bitter almonds, pungent acid like, mild to severe garlic, horseradish, soap, slightly geranium smell, alcohol and ammonia mixture, or strong to light fish odor. Knowledge of odor threshold types, not normally encountered on routine area calls, may assist emergency responders in assessing a chemical agent incident in preparation, in progress or in completion. The above odor threshold examples are not all inclusive and do not account for next generation weapons.

- Preparing CBRN detection instrumentation at the departmental level requires proper maintenance, continual training and correct utilization of all available CBRN agent detection methodologies and instrumentation in the department and mutual aid agencies.

- Detection monitoring training and refresher training done before CBRN operations commence should allow a higher level of mission accomplishment during actual CBRN response. The actual detection of CBRN agents is likely the most difficult aspect of a CBRN incident response.

- Currently, CBRN agents are not easily detected with monitoring technology available to emergency responders. Most direct reading monitors or hand held detectors/detection equipment have limited sensitivity and selectivity when it is necessary to give a "yes" or "no" to agent presence. The monitoring limits of detection (LOD) for the most common hand held fielded instruments are typically higher than the expected CBRN exposure levels capable of causing harm to exposed emergency responders. Additionally, the lack of agent selectivity or the potential for response to interferences from fake or "non-true" agents, may prevent first responders and first receivers from making a determination that a potential CBRN agent is present/**positive;** not present/**negative**; not present but detector reads that it is present; or may be present/**false positive** or present, but the detector reads it as not/**false negative.**

  The clear identity of the agent or agents is best determined by more specific monitoring technology, like that typically found in laboratory-based instrumentation at the county, state or federal public health or scientific research level [Kennedy, Eugene: November, 2004].

- The action of CBRN agent detection is the lynchpin of emergency responder safe operations under CBRN conditions. Available qualitative and quantitative detection instruments can be maintained and kept ready to assist in assessing gross CBRN agent presence at the response site. These instruments will also provide an indication of the presence of CBRN agents on personal protective equipment, to include CBRN SCBA. However, the results from these instruments should not be used to determine "all clear" areas to determine the absence of contamination on equipment or personnel, or to quantify the type of contamination present. Detection accuracy is paramount and therefore, sample collection operations should use highly reliable laboratory methods and a documented chain of custody. The health of responders and the potential discarding or saving of responder equipment will rely on the quality of laboratory methodologies used to determine the existence and identity of a CBRN agent. Examples of direct read instruments and kits available today are common military products such as the M256A1 kit, M-8 paper, M-9 tape, the chemical agent monitor (CAM), the improved chemical agent monitor (ICAM), the ICAD miniature chemical agent detector, ABC-M18A2 chemical agent detector kit, the M272 chemical agent water testing kit, and the

APD-2000 CW agent detector (this list is not all inclusive). Examples of rapidly changing civilian products are developments in wireless gas detection, surface acoustic wave (SAW)-based CWA and TIC detectors, RAZOR™, field hardened, biological agent detectors and multi-ion mobility spectrometer (Multi-IMS) CWA and TIC detectors. These hand-held direct reading instruments may contribute to assessing the local contamination presence and help establish zones of protection (Hot Zone/Red Zone, Warm Zone/Yellow Zone or Cold Zone/Green Zone), however, the instruments are subject to interferents and inadequate lower level of limit of detection. A laboratory qualified to make chemical agent identification should be used to determine the type and quality of CBRN agent present.

- Initial detection/monitoring of qualitative and quantitative results are important in providing risk assessment criteria to the incident commander for determining the start time of use life for a CBRN SCBA and other relevant PPE.

- Pre-maintenance checks and operations are necessary before "use operations" start to ensure all available detection instruments are operational within manufacturer specifications and the instruments are pre-positioned to support ease of use.

- The necessity to confirm, by means of either qualitatively or quantitatively monitoring, the presence of chemical warfare agents is critical because without some form of detection, the incident commander must assume the "worst case" and consider all CBRN SCBA as contaminated from initial onset of incident response to a CBRN event. The practice may result in numerous CBRN SCBA respirators being discarded at the end of the first 6-hour period, if detection measures are not fully qualified and implemented in support of hazard zone analysis, respirator selection and respirator use logic. Default timing concepts may be used if detection is not possible and may involve quarantine of suspected CBRN SCBA until monitoring results are available.

- NIOSH CBRN SCBA use life limitation of one total 6-hour period following the initial confirmed exposure to a chemical warfare agent is highly variable if detection instruments are not used to identify that something is determined present.

DECONTAMINATION PREPARATION OF CBRN SCBA

- In order to conduct decontamination operations during a CBRN incident response, proper training, decontamination methods and decontamination equipment should be procured in advance. Individual emergency responders will benefit from the use of immediate decontamination processes that help in removing gross CBRN contamination from PPE and other surfaces. A decontamination plan should be in place and appropriate skill level decontamination training should be part of a CBRN emergency response plan.

- Currently, gross decontamination with plain water is the most common decontamination process in use by fire department emergency responders.

- The use of disposable protective ensemble suits that encapsulate the responder and the CBRN SCBA may prevent contamination of the SCBA and the responder and thus limit the amount of decontamination and disposal operations. This standard protective measure was effective in recent anthrax responses whereby

the disposable ensemble was discarded while retaining the SCBA.

- Decontamination methods should be employed that address the particular CBRN agent type, **if known.** Decontamination processes, based on EPA adjusted bleach pH methods, have been demonstrated by the EPA as capable of providing upwards of six logs of kill effect for biological agents, after sufficient saturation time on porous or hard surfaces. This means that with the proper use of pH control measures, exponential logs of kill can be achieved by maintaining proper pH ranges of the decontamination solution. Methodologies for decontamination of select chemical warfare agents, biological agents or toxic industrial compounds are formulated by the EPA. [EPA, April 2005].

  Note: Various bleach solutions may deteriorate or etch some SCBA harness materials and may not be detectable by the wearer at the time of deterioration. [MSA, 2004].

  For additional information regarding the adjusted bleach pH method of decontamination see the following links: http://www.fema.gov/txt/areyouready/areyouready.txt
  http://ehp.niehs.nih.gov/members/1999/107p933-974munro/munro-3.html
  http://www.epa.gov/etv/verification/testqa-index.html#bdt

- Depending on the suitability and availability of individual decontamination kits for emergency responders, CBRN SCBA may benefit from emergency responders having local individual decontamination kits such as the M258A1 or M291 kits available to remove gross CBRN contamination at the time of exposure.

- Caustic solutions of decontaminates, while routinely available, will deteriorate CBRN SCBA and other PPE.

- Decontaminated CBRN SCBA, as determined by field measurements, should be isolated and held until the decontamination is confirmed by qualified laboratory tests.

ELECTRONIC COMMUNICATIONS

- CBRN SCBA are approved with specific communications accessories and before use operations should ensure communications platforms and accessories are mounted correctly and do not impede form, fit or function of the CBRN SCBA.

- Before operations actions for communications products on CBRN SCBA should be conducted in accordance with local fire ground SOP, SOG or All Unit Circulars (A.U.C.)

EXTREME WEATHER CONDITIONS

- CBRN SCBA being prepared for readiness before use operations in possible extreme weather conditions should be maintained per the manufacturer user's instructions. Usually, SCBA user's instructions contain the minimum use temperatures for operating the SCBA. If the UI does not state this, contact the manufacturer. Application of anti-fog coatings to the interior of the lens may be required prior to use in a cold temperature environment.

- Extreme weather conditions, such as freezing temperatures, are not ideal conditions for CBRN agent employment. HD becomes solid at temperatures equal to or lower than 14.45 °C /54.5 °F [Department of Defense, January 2005]. However, as the temperature increases, it is generally understood that HD contamination will recreate permeation and penetration hazards as it melts.

- Confined spaces may present high ambient temperature conditions. CBRN SCBA is designed to withstand appropriate high temperature exposures per NFPA 1981 compliance testing. Users should refer to NFPA 1981 or the appropriate user's instructions for temperature use ranges. All NIOSH CBRN SCBA have been tested at a relative humidity of 50 +/- 5% and a temperature range of 25 +/- 3 degrees C.

MIXING OF NON-CBRN/INDUSTRIAL, NON-CBRN/NFPA AND CBRN PARTS

End users focused on management response realize that readiness before use operations such as equipment preparation, equipment load planning, and equipment re-supply, contribute to the extent of mission success. If parts of CBRN SCBA are inadvertently mixed with any type of non-CBRN SCBA parts, NIOSH approval is void and death or severe injury could result from use of what is becoming known as a "Mismatched SCBA." The CBRN SCBA approval is only maintained when the parts and accessories listed on the official NIOSH approval matrix maintained by NIOSH and the official NIOSH SCBA label issued with the manufacturer's user's instructions are used. Crisis decision-making, for firefighters and emergency medical personnel, primarily focuses on saving lives and requires careful assessment of compatible NIOSH CBRN SCBA and industrial SCBA.

Mismatch of those two different types of SCBA will void the NIOSH approvals of both and may result in death or serious injury to the wearer. Non-CBRN parts cannot be substituted for CBRN parts. Furthermore, a CBRN SCBA with substituted non-CBRN parts is not expected to provide the same level of protection as a correctly assembled CBRN SCBA using the specified parts in the approval matrix. Select manufacturers use color-coded critical parts of a CBRN SCBA in an effort to prevent mismatching and for ease in identification and reassembly.

INTERCHANGEABLE COMPRESSED AIR CYLINDERS FOR CBRN SCBA

- NIOSH-approved CBRN SCBA is required to use specified compressed air cylinders/bottles as listed on the approval label

- Variations between NIOSH-approved CBRN cylinder neck valve assemblies and Non-CBRN cylinder neck valve assemblies may exist for field deployed SCBA, however, with the advent of NIOSH CBRN SCBA marketing, those variations are slowly being changed due to the fact that most new cylinder neck valve assemblies are CBRN approved and manufacturers have chosen to make the CBRN neck cylinder part number standard on either an industrial SCBA or a CBRN SCBA [NFPA 1981 TG Interchangeability, 2005].

- Crisis response may force an incident commander to use different CBRN SCBA air cylinders/bottles on compatible air pressure range hardware. "Like" air pressure duration cylinders from different manufacturers are not recommended for interchange between NIOSH CBRN SCBA. Their use will void the NIOSH CBRN approval and may cause a safety hazard, especially in the case of a field deployed, non-

CBRN approved cylinder, fitted to a CBRN approved hardware system.

- The use of any prototype universal cylinders, such as a NFPA Universal Cylinder and Valve Assembly, is not NIOSH-approved and will void the NIOSH-approved CBRN SCBA.

DURING USE OPERATIONS

Donning

CBRN SCBA are expected to be put on or donned in clean or CBRN contamination-free environments. CBRN contamination is itself unpredictable due to many variables. If, as a CBRN SCBA user, you are caught off-guard by a secondary or primary CBRN device explosion, spray, or other source of contamination, close your eyes, hold your breath and don the CBRN SCBA facepiece and regulator as quickly as possible. Do a user's seal check while still holding your eyes closed in case you have inadvertently trapped agent while donning the facepiece. Use of the red bypass valve to clear the respirator is also an option but contingent upon how much air is available. Placing the SCBA on your back should be a priority only after you have successfully donned and activated the CBRN SCBA. Use of the reduced profile maneuver in reverse, may allow enough time to protect the respiratory system from exposure. Resume normal SCBA wear posture once the situation is stable or if the requirement to evacuate the area is specified. A second person may need to provide the required assistance to effectively don the SCBA when the facepiece is donned and activated separately, before placing the SCBA on the back.

Note: Each individually manufactured CBRN SCBA may have unique donning measures required to be performed before or during donning. Do not use a partially full cylinder for CBRN SCBA response. If the cylinder is not full, the service time is reduced accordingly. The use of a cover lens on CBRN SCBA facepieces/visors may provide an additional layer of protection to the facepiece or may catastrophically fail when exposed to HD in particular, if not NIOSH-approved for CBRN. Do not use the respirator if hissing or popping sounds are heard from the SCBA during donning/activation. SCBA. Pressure gauge readings should correspond correctly when all air leak checks are conducted. Any regulator seating rings not seated properly in grooves should be re-aligned properly. The planned use of an integrated PASS panic button could provide a standardized warning measure to fellow responders that a CBRN event has occurred on the site. Ensure that you consult with the respirator manufacturer service repair if any obvious or delayed performance indicators are not working properly before responding to an incident. If the SCBA malfunctions during use, notify IC, seek air re-supply and initiate egress actions as quickly as possible.

Recommend strict attention to the readiness before use training conducted for CBRN SCBA and frequent reading of every page of the UI on a regular basis for rookie responders to ensure that unique donning practices such as turning an 'AIR KLIC' device counterclockwise to tighten it or ensuring a slide is debris free, are in familiar prior to donning the SCBA.

Use

Actual use actions, after successful donning of the CBRN SCBA, are dictated by the type of incident response (CBRN, CBRNE, B-NICE, Explosive, TIC etc.). If, during use the CBRN SCBA faceseal is broken, every

effort should be made to escape the hazardous area. While escaping, attempt to regain the facepiece seal by performing the manufacturer's facemask user seal/fit checks or other appropriate methods such as "purge-on" etc. In CBRN contaminated environments, over pressure, also known as positive pressure from the pressure-demand SCBA, may provide a level of protection, but CBRN certification tests have shown that a uniform, firm, face-to-facepiece seal is one of the measures to protect the breathing zone during inhalation and exhalation. Static pressure, which is the pressure in the facepiece at 0 psig flow, can range between 0.0 to 1.5 inches of water pressure. A NIOSH-approved SCBA is designed to maintain positive pressure in the facepiece during the NIOSH breathing machine test at a ventilation rate of 40 liters per minute or 115 liters per minute peak flow. During the inhalation cycle of a breathing machine, the facepiece pressure can vary from 1.5 to 0.0 inches of water column pressure. Static air pressure in the breathing zone of a NIOSH-approved SCBA is less than 1 psig. It has an exact range of 0.0542 psig to 0.1265 psig or 1.5 inches to 3.5 inches of water pressure [NIOSH, 2001].

Wearing

SCBA may have different meanings to different types or levels of responders. It may mean having the SCBA harness on your back, with the facepiece in a standby hanging position on an equipment hook, or fully wearing the entire respirator, per the applicable user's instructions.

Using

The SCBA may mean having the facepiece donned and using air while the SCBA hardware is on one's back or in the reduced profile maneuver position.

Current day examples of when SCBA are actually used have been discussed in numerous publications. However, actual specific use requirements for SCBA wear/use are normally directed by local departmental regulations. A search of relevant literature search shows that generally, all emergency responders use SCBA when performing the following typical response actions:

- Interior structural firefighting operations to save lives
- Interior structural firefighting operations when toxic substances or smoke are present and all civilian personnel are evacuated
- Operating at outside positions while being exposed to smoke or toxic substances downwind or upon entry
- Operating in confined spaces as defined in training bulletins or other standard operating guidelines
- Other than structural operations, emergencies as necessary, etc.

Removal of CBRN SCBA under those conditions, when used, is also regulated locally, but generally, responders operating in smoke or toxic atmospheres, CBRN included, should not remove CBRN SCBA facepiece except:

- When in a clean area

- The cylinder is depleted and in a clean area
- The SCBA is malfunctioning so as to terminate air supply and enough respirable air is available to allow egress
- The downed firefighter SCBA is empty and rapid intervention team (RIT) responds in a life saving support mode with no risk to agent exposure

The emergency responder must be aware that the risk of removing the facepiece in a CBRN environment may result in exposing him/herself or the intended-to-be-rescued responder, to a minimal, significant, or fatal exposure. CBRN agents are more lethal, toxic, potent, and faster acting than other toxic hazards normally encountered on the fire scene or crime scene.

The sharing of CBRN SCBA between emergency responders is not recommended, whether it is the same facepiece that is being shared or the same entire SCBA or separate hardware. Rapid intervention team (RIT) response may require the sharing of respirators to allow escape. If used, the practice of going on and off air, as the situation allows, in CBRN contamination, is very likely to cause minor, to major CBRN agent exposure, resulting in acute or chronic health conditions or death.

The use of "bite bars" or other devices designed to modify the air pressure boundary of a CBRN SCBA are not recommended. Emergency responders are cautioned against jeopardizing their health by non-compliance with NIOSH CBRN SCBA approval requirements, non-use of appropriate NIOSH CBRN approved respirators or by the possible use or mis-use of non-manufacturer specific modifications or adapters while using the CBRN SCBA.

CRUL AS IT RELATES TO END OF SERVICE TIME INDICATORS (EOSTI)

CBRN SCBA have standard NFPA and NIOSH EOSTI. Use EOSTI is highly recommended to ensure that proper escape/egress time is pre-planned and executed. Any local changes to the manufacturer's set EOSTI are the responsibility of the manufacturer and, if required, to the organization/department/agency that purchased the SCBA. Significant modifications to previously approved EOSTI engineering designs require NIOSH approval.

CBRN SCBA cylinders and components have an expected service life and service time, and when contaminated, an expected use life (CRUL = six hours). Indicators relevant to both service life and use life should be observed. An improvised CBRN agent contamination use life "indicator" program may use default timing procedures that rely on a stoppage of use at the three (3) to five-hour (5) CRUL mark, if on-the-job workplace detection methods are not present, or are present, but not rapid enough, or unreliable. This does not change the CRUL time value of six hours, but provides a safety factor to allow the responder to egress. Processing of contaminated SCBA at that time, may involve SCBA equipment quarantine until environmental sample results from the response scene are available one, two, or three days later. Most likely, if sample results do not the confirm type of contamination within one day, contaminated CBRN SCBA in the default timing pattern should be considered for discard due to the potential for CBRN, specifically chemical agent, permeation.

Field-deployed SCBA upgraded to CBRN protection that is used for six hours in a CBRN chemical agent contamination response cannot have select retrofitted parts changed out and replaced and the CBRN SCBA made serviceable for use. Chemical agents do not distinguish between old or new parts, just the susceptibility of the material to penetration or permeation effects.

USE AND CAUTIONS AND LIMITATIONS STATEMENTS

NIOSH cautions and limitations (C&L) are lettered and cover a variety of industrial and CBRN respirator approvals. They are understood to be assigned by NIOSH in alphabetical order and certain letters may appear to be missing in certain NIOSH respirator specific publications. They are missing because they are not applicable to the class of respirator or type of protection being addressed. For example, CBRN SCBA C&L are lettered I, J, M, N, O, S and then Q, R, T and U. The missing cautions and limitations letters of "P," "V," etc., are not present because they are not assigned to that class of respirator

CRUL/USE RELATED TO RIT OR RIC/UAC

Rapid insertion team (RIT) operations for emergency responders wearing CBRN SCBA are becoming more commonplace. RIT use universal air connection adapters and lines to mate up with downed responders and provide the downed responder lifesaving respirable air. While the integration of a universal rapid air connection/universal air connection (URC/UAC) assembly or any extension air system accessory is recognized on a NIOSH-approved CBRN SCBA, NIOSH does not approve CBRN "protection" for the actual use or a RIC/UAC/URC/extension air system accessory female connectors or air sources in a CBRN environment. NIOSH approves only the integral RIC/UAC male connector located on the approved CBRN SCBA hardware and not the actual connection of the RIC/UAC to a compatible interface in a CBRN environment.

USE RELATED TO QUICK-FILL ® /QUICK CHARGE

Use of authorized accessory assembly air hose lines integrated with NIOSH CBRN SCBA approved hardware to quickly fill depleting air cylinders under potential or CBRN contaminated environments is not approved by NIOSH. However, NIOSH CBRN SCBA do have approved air hose assemblies integrated per manufacturer applications and these devices are safe while integrated to the CBRN SCBA. Only the male connectors are NIOSH CBRN approved. Female quick fill connectors are not approved.

If quick charge/quick fill operations are done, the quick charge of a backpack mounted, compressed breathable gas cylinder should be done in a clean, protected, and 'CBRN contaminate free' area. And if performed in a contaminated area, the cylinder replenishment should be upwind of the contamination, completed as quickly as possible, and only for life saving measures as directed by the incident commander or existing lead federal agency.

Rest cycles for responding personnel should be implemented. Fire academy training courses and first responder comments show that the most likely time for a responder to rest is when the air cylinder is being exchanged for a full cylinder.

USE RELATED TO THE RED BY-PASS VALVE

A red colored by-pass valve is required to be present on all NIOSH CBRN SCBA. If a CBRN SCBA second stage regulator fails in the closed position, the red by-pass valve is used to provide forced compressed air into the second stage regulator area and the breathing zone/nose cup while by-passing the second stage regulator first breath activated mechanisms. The actual turning of the by-pass valve to purge the air line has not been done under NIOSH CBRN SCBA certification test procedures. However, NIOSH has demonstrated that the purge valve does maintain a safe air pressure boundary while disengaged in CWA LAT because of the simple deduction that the by-pass valve did not fail or contribute to failing properties of the tested CBRN SCBA. Since the air pressure boundary at the purge valve does not allow GB, HD or corn oil penetration or permeation while the boundaries are pressurized, it is deduced that activating the purge valve will not have an adverse effect on the wearer while CBRN agent conditions are present. However, further research and testing is warranted in this area to determine the effects generated by turning the bypass valve on in a CBRN contaminated environment.

Note: **Operating the by-Pass valve, also commonly known as the purge valve, should only be used for escape purposes. Emergency responders wearing CBRN SCBA should exit the scene in accordance with local requirements, when any type of malfunction is detected on the CBRN SCBA. Using the red by-pass valve, to by-pass the second stage regulator will expend air at a faster rate from the compressed air cylinder of the SCBA and provide an immediate flow of rapid breathable air into the breathing zone of the user. Emergency responders that have subdued red purge valves must be thoroughly trained in advance to use the purge valve as an escape method under CBRN contaminated or CBRN exposure conditions.**

PREPARATION FOR ESCAPE

Use of the by-pass valve/purge valve or normal second stage regulator is recommended for preparing to escape from CBRN contamination. In the situations where gear bags or other equipment are brought into a CBRN contaminated area, responders should exercise caution as it relates to contamination transfer from those items during the egress. The use of gear bags or extra vital equipment during a CBRN response may serve to spread contamination or unknowingly carry it to other exclusion zones of the site. Detection methods serve as vital measures to ensure that CBRN contamination has not spread, and is mitigated and contained within workable exclusion zones.

CBRN SCBA FAILURE

If CBRN contaminates are suspected or known to be inside your facepiece, close your eyes, hold your breath, use the By- Pass Valve to purge/flush suspected contaminates out as fast as possible, reseal the facepiece and grossly decontaminate known agent locations on the equipment and yourself, and then, or simultaneously, immediately escape out of the contamination.

With proper training CBRN SCBA are not expected to fail, provided the SCBA is fully serviceable and the respirator is worn and used correctly. CBRN SCBA failure indicators may be rapid or slow. Penetration or

permeation of CWA, TIC or biological contaminates into the breathing zone will likely be the first indicator the CBRN SCBA has failed or is starting to fail. A second indicator may be grazing or seam cracking of select SCBA material surfaces, especially those under pneumatic pressure or manual tightening. When this occurs and if it is noticed, acknowledge it and make a risk assessment based on the amount of air left, mission requirements and expected egress time to complete the mission.

If catastrophic failure of a worn CBRN SCBA occurs due to a failing cylinder, the emergency responder must perform a quick release of the SCBA or be prepared for serious injury or death due to the sudden kinetic energy expenditure of pressurized air from a cylinder neck valve breach, crack, or external causes resulting in cylinder catastrophic discharge. Depending on the level of protective suit ensemble or duty uniform worn, the SCBA harness assembly and cylinder will present significant hazards to the wearer while it is discharging. If hastily removed, the responder may likely sustain fewer injuries than if the responder kept it on and tried to ride the discharge out. The need for further research is warranted relative to catastrophic cylinder breaches under fire, law, hazmat and emergency medical response conditions.

If possible, the by-pass valve "purge-on" action is recommended for escape purposes when the breach is noticed and as soon as any sign of SCBA failure is detected. Use of the by-pass valve will deplete cylinder air pressure faster than second stage regulator operations.

The responder two-man rule is even more critical in CBRN responses. Much like routine fire responses, the use of buddy teams/two-man rule (OSHA 2 in, 2 out) should assist in detecting pre-failure indicators. For lengthy decontamination processes, supplied air line respirators (SAR) with compressed air cylinder escape bottles can be used, provided the air lines are kept clean of contamination. As of 2005, NIOSH has not approved SAR with CBRN protection nor has NIOSH begun concept development of a law enforcement specific CBRN SCBA standard.

CBRN SCBA ACCESSORY FAILURE

CBRN SCBA accessory failures, due to malfunction or CBRN caustic effects, will cause the accessory to be discarded or rendered un-usable. If only a specific accessory, such as the integral PASS device is splashed with liquid CBRN agent, the remaining SCBA hardware may not be contaminated. Monitoring of the SCBA with litmus paper sampling (known as "papering") or hand held calibrated point detectors may assist in determining the range of contamination splatter on a CBRN SCBA. Knowing exactly where the contamination is at on the equipment assists in more rapid surface decontamination. Gross decontamination should nevertheless, still be done with the understanding that toxic run off should be prevented from contaminating the rest of the SCBA and surrounding area. Contamination avoidance through the use of fine spray nozzles or localized washing of suspected components of the CBRN SCBA may reduce the amount of contamination from spreading, penetrating or permeating equipment surfaces.

WITHDRAW

Only clean, non-contaminated CBRN SCBA should be withdrawn from the incident site in accordance with the relevant local departmental protocol. CBRN SCBA contaminated with chemical warfare agents should not be withdrawn for any reason, especially future use, from an incident site. Contaminated CBRN SCBA should be handled appropriately through a defined equipment route for proper decontamination, accountability and eventual disposal.

ESCAPE

CBRN SCBA do not provide integral escape bottles or other means of providing escape air, except through use of the by-pass/purge valve. Use of RIT to provide replenishment air is subject incident commander authority and most likely will only be used to save a life, but not to extend work times in a CBRN environment.

AFTER OPERATIONS

Unmasking Procedures

Unmasking procedures or removal of the facepiece while on air should only be performed after the ambient air has been characterized to be below the determined safe exposure limits for a particular CBRN agent or agents. NIOSH CBRN SCBA should not be removed, for any reason, while wearer is still in a CBRN contaminated environment. Before unmasking procedures are conducted, ensure that local decontamination of equipment has been performed. An appropriate decontamination procedure should be selected based on the type of contamination involved or expected, known effectiveness of the procedure, estimated or known procedure dollar cost, availability of decontamination materials, and ease of decontamination process implementation. The use of qualitative detection technologies, coupled with voluntary unmasking procedures (unmasking procedures with or without the M256A1 kit) is not recommended in an actual or suspected hot zone or warm zone of a CBRN incident.

Doffing

Doffing/removing taking the CBRN SCBA off is a deliberate process outlined in appropriate SCBA user's instructions. In the case where CBRN contamination is known to exist, removing the CBRN SCBA should only be done under strict contamination control measures and decontamination procedures. If the CBRN SCBA is clean, doffing should be done in a safe area.

Handling of CBRN SCBA

Handling is defined as to touch, lift or hold with the hands. The respirator may be lifted with the hands or remotely by robotic tools. NIOSH CBRN Cautions & Limitations letter 'T' states that direct contact with CBRN agents requires proper handling of the SCBA after each use and between multiple entries during the same use. Proper handling involves prevention of CBRN contamination spread and cross contamination of known clean items. If re-entry is performed while using the same CBRN SCBA, use recommendations should be strictly observed. Handling of contaminated CBRN SCBA should contain and mitigate all forms of CBRN contamination in accordance with the correct procedure relevant to the type of agent exposure. Universal handling procedure used by hazardous material operators are recommended in accordance with OSHA HAZWOPER requirements. Actual handling of contaminated CBRN SCBA requires proper dermal and respiratory protection appropriate to the type of agent exposure. NIOSH-approved CBRN SCBA and NIOSH-approved CBRN APR are recommended as respiratory system protection during handling of contaminated CBRN SCBA equipment scheduled for disposal.

Individual Equipment Decontamination

If known CBRN contamination is present on the CBRN SCBA, the most effective action to do is gross decontamination wash-down with water to remove any visible or detectable type of CBRN agent. CWA will not be neutralized by water, but rather diluted to a safe level and physically washed off equipment surfaces. It is expected that massive amounts of CBRN particulates will be washed off, yet trace particulates will likely remain in intricate crevices of the CBRN SCBA. Gross decontamination with water is expected to limit CWA agent penetration and permeation. CBRN SCBA, if confirmed to be contaminated by available laboratory results, may produce evidence to use default timing rules where the CBRN SCBA that was suspected of being contaminated is now known to be contaminated or clean and is then used in known contamination for an additional 3- to 5-hours if it was known to be clean or, if dirty, its use is does not exceed the total 6-hour limit.

CBRN SCBA Facepiece Decontamination

In Level B OSHA/EPA protective ensemble protection or other recognized consensus standards levels such as NFPA 1991 or 1994 classes, usually only the facepiece, second stage regulator, and hose assembly are expected to be exposed to CBRN contamination. In the process of decontamination, decon methods of wash-down with copious amounts of water may limit the amount of CBRN contamination spread to the remaining areas of the CBRN SCBA. The controlled substitution/replacement of only the contaminated parts of the CBRN SCBA, in and attempt to continue to use the un-contaminated components of the SCBA, would be extremely difficult and may not prevent cross contamination of the interior air-pressure boundaries, and is not recommended.

CBRN SCBA Cylinder and Hardware Decontamination

For biological response, EPA guidance calls for use of adjusted pH bleach on hard surfaces. See the link for additional information on adjusted pH:
http://www.epa.gov/pesticides/factsheets/chemicals/bleachfactsheet.htm
A CBRN SCBA used in a biological response may be decontaminated using soap and water and a neutral 0.5% hypochlorite solution. This solution, close to, but not above, pH of 7 and 5,000 to 6,000 parts per million in strength, can be prepared by mixing one part bleach (5.25%-6.00%) to one part white vinegar, to eight parts clean water. Bleach and vinegar are not combined together at any point in time; rather, some water is added to the bleach, then vinegar, and then the rest of the water. The pH of the solution must be tested routinely with a paper pH test strip. Ensure that pH test strips are available. Treated surfaces must remain in contact with the bleach solution for 60 minutes and repeated applications or emersion will be necessary to keep the surfaces wet. Additional CBRN agent decontamination methods are available at CDC search engine http://www.cdc.gov/az.do#S.

Detection Methods In Support of Decontamination Operations

To determine the effectiveness of decontamination operations, relevant detection instruments should be used to confirm that CBRN agent decontamination has been effective. The current source point or direct read quantitative monitors available for CBRN detection are limited in type and capability. Most of the available technology has limited sensitivity and selectivity. Detection methods using laboratory results to confirm the effectiveness of decontamination is currently the best recourse. Qualitative monitoring devices such as U.S. Army M8 paper, M9 tape, M256 kit, M256A1 kits, CAM, ICAM, ACADA, or other detection equipment may

not provide the degree of quantification necessary to fully determine CWA presence or absence. End users should rely on repeatable results from certified public health or federal laboratories to substantiate key decision-making processes. In the interim, the repeated use of reliable qualitative monitoring devices to help in establishing site control measures and exclusion zones may prove beneficial until quantified results are available. Next generation biological agent detection measures are improving daily but are not field deployed yet at the individual end user level. Radiological agent detectors are available and deemed adequate to quantify dosage, presence and removal of radiological particulates and nuclear fallout.

Recommendations for Disposal

CBRN SCBA, once decontaminated to the best level possible, require special handling for disposal. Users of CBRN SCBA will likely not have the decontamination resources to bring CWA contaminated SCBA to regulatory HAZWOPER levels of agent concentration. Users should ensure that all types of CBRN SCBA, regardless of the type of contamination, are double bagged in the appropriate shielding material, labeled with the type of agent or agents, and the amount and type of gross decontamination solution used. The amount of exposure time for the contaminated SCBA, the concentration, and the amount of CBRN contamination is also beneficial information relative to disposal. Adherence to local, state and federal disposal procedures involving incineration, for specific CBRN agents, is required.

Cleaning and Sanitization of CBRN SCBA

A CBRN SCBA contaminated with CWA will not be cleaned and sanitized for any type of re-use. CBRN SCBA contaminated with biological particulates, biological toxin or radiological particulates require detailed decontamination and most likely re-use will not be cost effective depending on the conditions of contamination. Recommended cleaning and sanitization procedures for non-contaminated CBRN SCBA follow the same manufacturer guidelines as for traditional SCBA. Information developed from the World Trade Center response is located at http://www.cdc.gov/niosh/respcln.html

Chapter 6: INTEGRATION OF CBRN SCBA WITH PROTECTIVE SUIT ENSEMBLES

NIOSH-approved CBRN SCBA and NIOSH-approved industrial SCBA are used by all types of emergency responders while wearing EPA/OSHA Level A, Level B, Level C protective equipment ensembles, EPA/OSHA Level D protection, NFPA ensembles, military mission oriented protective postures (MOPP) or military self-contained toxic environment protective outfits (STEPO)/improved toxicological agent protective ensembles (ITAP). They are also used with Explosive Ordnance Disposal (EOD) suits.

As of 2005, NIOSH CBRN standards do not exist for protective ensembles, therefore, NIOSH/NPPTL do not certify protective suits for CBRN protection. NIOSH/NPPTL bench mark testing, evaluation, recommendations are underway. Next generation chemical/ biological protective ensembles are being developed by select private sector companies under contract to the Department of Defense and the NFPA. NIOSH/NPPTL only certifies CBRN respirators as systems. Currently, NIOSH/NPPTL does not certify protective ensembles/suits as major components of a NIOSH CBRN approval.

In light of this information, there are several aspects of use that are addressed in the following paragraphs. They focus on chemical suit pass-thru-devices, HAZWOPER Level A, B and C protections, and CRUL values while wearing a protective ensemble, CBRN SCBA facepiece interface methods, and EOD suits

INDUSTRIAL PROTECTIVE ENSEMBLE/CHEMICAL SUIT PASS -THRU DEVICES

CBRN SCBA, with approved auxiliary hose line assemblies, may interface successfully with stand-alone, integrated, specific chemical suit pass thru devices. These pass-thru devices allow airline connections to literally "pass through" designed suit openings. They normally consist of airline pigtail designs using Hansen, Schrader, or Foster connections. A special adapter from select respirator manufacturers is available for Level A suits. Airline pigtail or auxiliary hose line assembly, present on NIOSH-approved CBRN SCBA, may allow CBRN SCBA to have non-compliant, but still acceptable air pressure exchanges in clean airline connections while in a Level A, fully encapsulated ensemble, provided the Level A ensemble is brand new and hydrostatic certified.

Note: The pigtail interface is not live agent tested in terms of the mating of an external airline to the pigtail.

The use of a chemical suit pass-thru device in CBRN environments is situation dependent and at the discretion of the incident commander. Currently, NIOSH does not issue CBRN protection approval to chemical suit pass-thru devices. However, the integrated SCBA air line and fittings that connect to the pass-thru devices must be NIOSH-approved in the first tier of approval, if it was correlated to the CBRN SCBA approval process. Interchangeability of the pass-thru device for purposes of interoperability between manufacturers is not recommended.

HAZWOPER LEVELS A, B, C AND D, PROTECTION OF THE WEARER AND HOW THE CBRN SCBA INTERFACES

Industrial hazardous waste operations and emergency response (HAZWOPER) operations pair up different classes of respirators with different types of protective clothing. The complete outfit, consisting of a respirator, suit, gloves, boots and other necessary accessories, is called an *ensemble*. Protective suit ensembles used in HAZWOPER are commonly described as levels of increasing protection starting at the lowest level of protection, Level D, to the highest level of protection, Level A [OSHA 1997]. As required by OSHA, personal protective equipment must be selected that will protect employees from the specific hazards that they are likely to encounter during their work on-site [OSHA, 1997]. The amount of protection afforded by selected PPE is material-hazard specific and dependent on accurate characterization of the workplace before entry. OSHA/EPA Levels D, C, B, and A are designed to provide increasing levels of dermal and respiratory protection from vapor, liquid, aerosol, and particulate contamination. Levels A and B provide higher levels of respirator and dermal protection than levels C and D. SCBA are required in Levels A or B ensembles. CBRN SCBA meets the OSHA respiratory requirements for HAZWOPER Levels A and B. CBRN SCBA, used in conjunction with a new regular production unit Level A ensemble, are expected to stay contamination free, depending on the quality assurance testing of the suit and local compliance to the applicable OSHA or EPA standard, and if applicable, the NFPA code. However, if the Level A ensemble is compromised thru fair-wear-and-tear (expected to be a possibility in an old RPU), snags, collateral damage from a secondary device, or poor quality construction, the end user should expect the NIOSH-approved CBRN SCBA to continue to provide its accepted standard of performance, even though the interior of the suit ensemble may be harboring dangerous agents.

Because Level A is considered burdensome on the wearer, CBRN SCBA are worn exposed to the ambient atmosphere, in Level B or Level C ensemble configurations. In some responder communities, head harness straps are worn over of protective ensemble hoods. NIOSH-approved CBRN SCBA worn with the head harness of the CBRN SCBA exposed to the ambient atmosphere could jeopardize the intended sealing properties of the CBRN SCBA facepiece and contribute to penetration of the wearer's breathing zone. Please ensure that the CBRN SCBA head harness is donned on the user's face, head first, and then the protective suit hood is donned over the head harness. Necessary measures to bridge the gap between the respirator's face blank and protective suit hood/neck material should be taken, as deemed appropriate by local ISO/HSO.

Integration of CBRN SCBA with firefighter turn out gear, law enforcement tactical field gear, Level A, B, C and D hazardous waste protective suit ensembles, NFPA 1994 Class 1, 2 or 3 ensembles, and NFPA 1991 ensembles or any other dermal protective barrier/suit used by the incident commander is possible. A direct transfer of the common industrial hazardous materials and waste response capabilities to the realm of CBRN incident response makes tactical sense, provided certain improvements and modified tactics, techniques, and procedures are identified and made available in current field deployed PPE and next generation regular production protective clothing and respirators. Crisis event commanders may weigh the constraints that Level A or Level B place on the responder and decide, in the interest of mission accomplishment under crisis response, to use CBRN SCBA in Level C for a specific tactical response. If this occurs, NIOSH-approved CBRN SCBA are approved as stand alone respiratory protection systems. How they are integrated with other types or levels of protective ensemble protection is not a NIOSH requirement for certification. NIOSH-approved CBRN SCBA will provide the required level of respiratory protection provided they are used accordingly. NIOSH-approved CBRN SCBA are not currently approved in tandem with any protective suit ensemble or suit sub-component. As discussed, respirator manufacturers outfit SCBA with compatible accessories for SCBA use in protective suit ensembles, such as suit pass-thru devices, auxiliary hose assemblies and rapid intervention team or crew/universal accessory connection accessories that support SCBA

compatibility with protective suit ensembles and portable air sources. Use of these compatible accessories for CBRN incident response is at the discretion of the incident commander or lead federal agency officer in charge.

CRUL

CBRN respirator use life of a CBRN SCBA or its CRUL time value does not start unless the protective suit ensemble is breached and allows minor to significant agent entry. Having a CBRN SCBA on under a Level A suit provides a barrier of protection to the CBRN SCBA, but does not change the CBRN respirator use live time value of six hours, (CRUL = 6). Granted, a non-federal compliant and tested suit can provide a level of protection to the CBRN SCBA from splash and vapor hazards, provided it is compliant to current available third party CBRN consensus standards such as NFPA 1994 or 1991. However, if that ensemble is breached by normal wear-and-tear, snagging, tangle, cutting or penetrating hazards, the interior of that ensemble (Level A or next generation ensembles of a Level A) may allow hazardous CBRN agents to accumulate and contaminate/expose the dermal areas of an emergency responder. Suit "protection factors" vary according to suit design and manufacturer.

CBRN SCBA FACEPIECE SEAL COMPROMISING

Doffing of the protective suit ensemble should not adversely impact the sealing properties of the NIOSH-approved CBRN SCBA, provided doffing actions are not overly severe. An adequate respirator human-face-to-faceblank-seal should be maintained by the end user or by use of the two-man rule/user team, while doffing protective suit ensembles.

EXPLOSIVE ORDNANCE DISPOSAL SUITS

Explosive Ordnance Disposal (EOD) bomb squad suits are designed to provide chemical and biological protection during low threat explosive ordnance detonation or improvised explosive device disposal operations (IED) involving CBRN agents. Select NIOSH CBRN SCBA are compatible for use with EOD suits. NIOSH-approved CBRN SCBA are worn on the outside of the bomb suit. For additional information about EOD suits available to emergency responders see http://www.med-eng.com/medeng_products_en/medeng_products_display_product.jsp?pID=5.
The following links contain relevant information pertaining to protective suit ensembles and respirator integration for CBRN response:
Biological: http://www.bt.cdc.gov/documentsapp/Anthrax/Protective/10242001Protect.asp
Chemical: http://www.bt.cdc.gov/agent/agentlistchem.asp
Radiological: http://www.bt.cdc.gov/radiation/pdf/MassCasualtiesGuidelines.pdf

Chapter 7: PROJECTED USER NEEDS

Firefighters and emergency responders, such as law enforcement special weapons and tactics teams, use SCBA that are NIOSH-approved, as well as standards developed by NFPA, principally, the NFPA 1981 "code" and others. These standards address certain respirator manufacturer requirements that are unique to firefighting and operations in hazardous atmospheres. In October of 2001, these standards did not address potential CBRN agents which could potentially penetrate or permeate through the SCBA. Analysis of potential hazards and materials of construction of the SCBA in October of 2001, led to the conclusions that the characteristics of the "facepiece to user" interface required verification for each SCBA marketed to the public workforce. Because gas and vapors are more penetrable than radiological and biological particles, the focus of SCBA CBRN testing was on chemical gas, vapor and aerosol penetration or permeation.

Currently, CBRN self-contained breathing apparatus approved by NIOSH can provide minimum respiratory protection against these agents; however, responders at the site may have only part of the information necessary to select the type of appropriate complimentary personal protective equipment (PPE) for the response. In situations where it is an initial response to a suspected CBRN terrorism incident, an actual CBRN incident, or a follow on response to a known CBRN incident, protection of the respiratory system is paramount and NIOSH CBRN certified, open-circuit, pressure-demand, self-contained breathing apparatus are highly recommended.

CBRN SCBA, when contaminated with CWAG-series nerve agents (GA, GB, GD, GF, GE), V-series nerve agents (VX, Vx, VE, VM, VS etc.), H-series (H, HD, HN, etc.) or L-series blister agents (L-1, HL etc.), become *single-use* respirators and have a *maximum use life of six continuous hours*. Remaining types of contamination consisting of toxic industrial chemicals (TIC), toxic industrial materials (TIM), fire debris, blood borne pathogens and biological or radiological particulates are treated in accordance with existing practices. Full, partial or initial characterization of the incident is a critical requirement. Numerous hand held current on-site detection methodologies that are used to characterize a CBRN incident are qualitative indicators that are limited in scope. Therefore, not all possible exposure limits in a CBRN incident response are expected to be initially known.

Selection of PPE for CBRN incident response requires a knowledge level commensurate with current experience in wear time, use time, maintenance time, and recovery time of PPE. Recent NIOSH Respirator Selection Logic (RSL), dated October, 2004, http://www.cdc.gov/niosh/docs/2005-100/ is not intended to be used in the selection of respirators for protection against infectious agents or for CBRN agents of terrorism. While the industrial respirators identified in the RSL can provide a variable level of protection against some of the irritating military/law enforcement riot control agents, such as CS, CN and pepper spray, they are not live agent tested by NIOSH and can, in fact, exhibit catastrophic failure when exposed to HD or GB while in a confined space. Additionally, the process safety information necessary to use the industrial respirator selection logic (RSL) is generally not available for infectious disease or bioterrorism agents (e.g., defined exposure limits and airborne and dermal concentrations). Likewise, CBRN terrorism events may involve chemical toxic industrial compounds or military grade/terrorism grade chemical warfare agents that can quickly degrade industrial respirator materials, penetrate industrial respirator silicon or other material air-

pressure boundaries. These toxic compounds and agents can build up in industrial respirator air-pressure boundary dead-spaces not flushed by exhalation air flow or have an extremely low toxic level that is difficult to quantify and measure on the incident site, resulting in a lack of proper respirator performance.

This CBRN SCBA user's guide and its companion training aid pamphlet are intended as reference materials for the proper use of a CBRN SCBA. The guide also enables assessment of field deployed SCBA to differentiate between CBRN SCBA and non-CBRN SCBA. The guide can assist in minimizing risks to American emergency response workers. In crisis response, it is expected that incident command assessments requiring NIOSH CBRN approved respirators should be invaluable. Actions before, during, and after a chemical, biological, radiological, or nuclear incident require pre-planning and are expected to be incident unique, very similar to recent natural disaster responses. The individual response to each type of contamination or types of contamination may require responders to do identical actions en-route to the site. However, once on-site, actions performed to contain, mitigate, evaluate, decontaminate, and close the site may vary by several factors, one of which will be the type of agent or agents present.

The National Personal Protective Technology Laboratory (NPPTL) of the National Institute for Occupational Safety and Health (NIOSH), certifies open circuit, pressure demand, self-contained breathing apparatus (SCBA) respirators for use by emergency responders and other qualified individuals responding to emergency events involving chemical, biological, radiological or nuclear (CBRN) agents and effects. The U.S. Department of Homeland Security (DHS) sanctioned this equipment certification process and requires the use of NIOSH CBRN approved respirators in the ongoing DHS domestic preparedness equipment grant programs. For more information related to CBRN equipment standards adopted by the DHS go to: http://www.dhs.gov/dhspublic/interapp/editorial/editorial_0420.xml.

NIOSH serves the occupational workforce under the administration of the Centers for Disease Control and Prevention (CDC) of the United States Department of Health and Human Services. NPPTL supports NIOSH with personal protective equipment technology research, respirator certification programs, site audit programs, firefighter fatality evaluation support, and respirator standards and policy development. NIOSH published CBRN SCBA certification standards under 42 CFR 84, paragraph 84.63, (a), (b) and (c) on December 28, 2001. NIOSH issued its first letter of approval for a civilian CBRN SCBA on May 31, 2002. On February 26, 2004, the DHS adopted the first civilian homeland security personal protective equipment standards for first responders and simultaneously endorsed the use of NIOSH CBRN SCBA, NIOSH CBRN APR, NIOSH CBRN APER, and NIOSH CBRN SCER technical evaluation and certification standards along with five National Fire Protection Association (NFPA) protective equipment documents. DHS made the NIOSH and NFPA standards qualifying criteria for processing homeland security equipment preparedness grant applications and purchases.

NIOSH CBRN SCBA approval letters are based on documented passing minimum laboratory performance requirements through rigorous tests and stringent evaluation of manufacturer quality-control practices, technical specifications, and other supporting documentation. A NIOSH CBRN protection approval signifies that an SCBA is certified by NIOSH to provide respiratory protection against airborne CBRN agents. Prior to NIOSH approval, the CBRN SCBA undergoes a compliance part number review before and after NIOSH live agent testing. This NFPA review and limited testing as necessary, is managed by the private firm, Safety Equipment Institute (SEI), in accordance with the National Fire Protection Association 1981, non-profit organization consensus document, for protection against structural fire hazards. The SEI label appears on all

NIOSH-approved CBRN SCBA. The CBRN SCBA approval requirements are designed to meet the stated consensus respiratory protection needs of emergency responders.

The recent TIC and improvised explosive devices discovered in Fallujah, Iraq, demonstrate how military personnel are using NIOSH-approved SCBA overseas [Combined Press Information Center, November 26, 2004]. Reports show US military forces uncovering clandestine Iraqi chemical laboratory operations inside an urban building in Fallujah, Iraq. Industrial chemicals were found adjacent to improvised explosive device parts and blasting caps. SCBA with Level C ensembles were used by military personnel during the Fallujah investigation. The personnel exhibited proper wearing of NIOSH approved SCBA with protective ensemble. Additionally, in May of 2004, military forces in Iraq, uncovered improvised explosive devices attached to Iraqi 155mm artillery ammunition rounds that reportedly contained binary forms of nerve agent [USA Today, May 18, 2004]. These are indicators of a working/developing threat from CBRN agents. Donning a CBRN SCBA quickly and wearing it correctly will prevent respiratory exposures to ambient concentrations of CBRN agents even under the most extreme conditions of confined space. This guide assists the user in determining what he or she needs to know regarding CBRN SCBA certification and compliance to support their mission. NIOSH cautions and limitations play a pivotal role in establishing the working use life of NIOSH CBRN SCBA.

The purpose of this document is to provide emergency responders with practical guidance on the recommended proper use of NIOSH certified CBRN SCBA for protection against CBRN agents. It has been accomplished thru various means. One, the publication of this guide, two, the publication of current certified equipment listings (CEL), and three, the use of NPPTL web pages to disseminate appropriate guidance. A list of current CEL approvals is available at: http://www.cdc.gov/niosh/npptl/topics/respirators/cbrnapproved/scba/.

NIOSH continues processing CBRN SCBA applications in the technical certification (TC-13F-) SCBA respirator schedule. Over the course of the next three years, NIOSH expects to provide respirator manufacturers the opportunity to have various classes of CBRN respirators approved and consequently continues to contribute to the national certified respirator inventory. This should allow manufacturers to offer end users a greater variety of respirators for different types of potential CBRN respiratory occupational workplace needs.

A CBRN closed circuit SCBA concept paper was published on October 30, 2004. Future CBRN concepts for combination open circuit SCBA with capabilities of supplied air and air-purifying modes are projected. For more information on new types of CBRN respirators in concept development go to the following links: http://www.cdc.gov/niosh/npptl/standardsdev/cbrn/scba/cc-scba/concepts/cc-scbacon103004.html and http://www.cdc.gov/niosh/npptl/standardsdev/cbrn/papr/.

INTENTIONS FOR USE

NIOSH CBRN SCBA respirators are intended for use by trained emergency responders for specific entry into or escape from unknown, known, suspected, or partially characterized CBRN hazardous environments. A hazard is defined by OSHA as the inherent capacity of a substance to cause an adverse effect [OSHA, 2003]. The DHS NRP defines a hazard as something that is potentially dangerous or harmful, often the root cause of an unwanted outcome. Defining a hazard helps in deciding how to respond to it. Emergency responders

could respond to single, multiple or combination CBRN hazards. Safe incident response requires the use of appropriate personal protective equipment. CBRN SCBA respirators are part of the range of PPE selection. At a CBRN emergency response hazardous event, respirators providing the highest level of protection should initially be used, and routinely used, as the mission dictates, until hazard types and concentrations are quantified and exposures are determined to be compatible with less protective CBRN respirators. Currently, the respirator configuration that offers the highest level of respiratory protection and inherent facial dermal protection is the NIOSH CBRN SCBA. Emergency responders and first receivers should use CBRN SCBA in conjunction with personal protective ensembles that provide appropriate levels of protection against dermal hazards.

A joint OSHA and NIOSH interim guidance document was published on the internet on August 30, 2004. It provides CBRN PPE selection matrix guidance based on potential toxicological levels of exposure. It defines red (hot), yellow (warm) and green (cold) zones and provides PPE recommendations for each zone, as they relate to CBRN contamination. The link to the joint OSHA/NIOSH CBRN PPE selection matrix is: http://www.osha.gov/SLTC/emergencypreparedness/cbrnmatrix/index.html.

Law enforcement responders (LER/LEOS) are using PPE, especially SCBA and APR. Clandestine lab entries are typical examples. CBRN responses/training are another. Standard Mil Spec and now NIOSH Industrial and CBRN approved "Gas Masks" have been and will continue to be integral to law enforcement personal protection. Go to NTOA.org for recent Las Vegas Annual Conference highlights. There you will see several courses. One is Tactical Use of SCBA in Hazardous Environments. PPE selection logic for LER are mission specific and do vary from sister responder services. NFPA compliant SCBA are not designed for LER mission response-they are designed for fire response. While they will provide protection and fire resistance to explosions, their ergonomic and tactical design is not totally optimal for a law responder. Ergonomic and technical improvements are needed for LER to gain maximum benefit from next generation PPE technology. Ballistic protection of cylinders, noise and light discipline of gauges, visors and exhalation valves, redundant air pressure alarms, and Level D/C/B ensemble interface with ballistic vests are all next generation projected areas that require standards publication-not to mention the explosive ordnance disposal tech requirements. Recent IED criminals are being incarcerated and the federal trail of the weapons grade spore generator is still evolving. Purple ops have routinely integrated land, sea, and air operators. Applying that to civilian response organizations will take trained purple operators as consultants.

Tactical operators/responders must be of highest integrity and honor. Use of deadly force to accomplish local missions carries significant responsibility: responsibility that prevents/contains out of control response when chaos ensues. DoD/USCG rules of engagement (ROE) are tailored to support local law enforcement and fire responders in the accomplishment of restoring law and order, infrastructure and recovery from natural disaster aftermath--that will also be the case in the event of a nationally significant CBRN attack(s). Natural disasters show that layers of emergency responders will be hampered, constrained or decimated and the lessons learned from ongoing emergency management operations can be multi-purpose in current and future applications at all levels of response.

CBRN RESPIRATOR USE LIFE (CRUL)

Quantification of known contamination on an SCBA starts with repeatable detection and sampling plans in place. Once contamination is confirmed or closely estimated, the administrative clock can start allowing safety coordinators to determine estimated contamination times and generate a time of use start point for a respirator use life, similar to a service life, but not identical. The purpose for NIOSH creating a CBRN respirator use life (CRUL) concept is to provide a guidance tool, in the case of the SCBA, to properly distinguish actual CBRN use from more common SCBA use terms related to service life or rated service time of the SCBA. The CRUL for a CBRN SCBA incorporates the known rated service times and system service life concepts and overlays the NIOSH CBRN SCBA cautions and limitations, to create practical use life guidance that provides maximum protection to the end user from the permeating and penetrating effects of chemical warfare agents. CBRN Respirator Use life assists in defining 4 variables: 1) how long a CBRN SCBA can be used based on the initial exposure to CWA, 2) how long the actual duration of use is dependent on real time use, 3) how long a contaminated CBRN SCBA can be used while it is contaminated or assessed as potentially contaminated and 4) when to discard the respirator. Rated service time of the cylinder dictates the amount of air available to the end user per one full air cylinder. CBRN SCBA, with refilled cylinders, has a CRUL of six hours. Contaminated respirators must be grossly decontaminated. The use of copious amounts of controlled water spray and runoff control is recommended before double bagging for disposal. A CBRN SCBA should be discarded/disposed of when a system is found contaminated or components such as facepieces, head harnesses, seals or hoses are altered due to CBRN exposure.

CBRN Respirator Use life for a CBRN SCBA is based on understanding and implementing the NIOSH listed cautions and limitations. An approved CBRN SCBA has 10 NIOSH required cautions and limitations applicable to the approved CBRN SCBA. They are lettered, rather than numbered, because the letters follow NIOSH alphabetical listings of cautions and limitations already in existence plus any new letters assigned to the statement of standard cautions and limitations.

In the CBRN SCBA case, the cautions and limitations are I, J, M, N, O, S, Q, R, T and U. Of those ten listed, four (4)-cautions and limitations (Q, R, T, & U) are specifically for CBRN response. All ten are published in the approval label as a paper insert to the user's instructions issued with the CBRN SCBA.

The ten cautions and limitation sentences and paragraphs are designed to ensure that minimum safety performance measures are integrated into the use of the respirator for the end user. In the process of using those cautions and limitations, a use life plan and practice for a contaminated CBRN SCBA can be developed by on scene commanders, safety coordinators and other personnel to aid in the determination of when and how to discard contaminated CBRN SCBA.

The use life concept of a continuous 6-hour period, beginning at the time of a confirmed CWA exposure, applies to the NIOSH CBRN SCBA currently. This is because the CBRN SCBA respirators are the only NIOSH approved respirators that have disposal recommendations written in the approved NIOSH cautions and limitations. Real time response actions will dictate actual use life parameters. It is expected to be understood that the detection of chemical warfare agent (CWA) contamination is key to determining a 6-hour start point of a CBRN SCBA CRUL. Therefore, calibrated instruments which are designed to reliably quantify CWA at known limits of detection should be available for use. Reliable qualitative detection instruments may be used to determine the presence or absence of chemical warfare agents but these same qualitative detection means (M8, M9 paper and M256A1 kits) are not ideally suited for determining contamination

concentration/presence in the breathing zones of CBRN SCBA or the effects of penetration/permeation on CBRN SCBA.

If on-site or remote detection instruments are not available, in place CBRN agent sampling procedures and the means to transport those samples to qualified laboratories should be options available to the incident commander. These laboratories can then generate quantifiable results detailing the presence or absence of confirmed CBRN contamination or the lack of it. Once detection monitoring confirms CWA at the site, the CBRN SCBA use life of six hours starts. A local, state or federal qualified public health laboratory should have the means and capability to confirm the CBRN agent type and quantity of agent present, provided the sample chain of custody is maintained. The actual use life start point time for a contaminated SCBA will likely require backward or forward time adjustment based on the verified public health laboratory results.

Use beyond the 6.0 hour "limit" in a confirmed chemical warfare agent incident violates NIOSH Caution and Limitation "U." However, in a real world situation, the incident commander may be confronted with the decision to implement use beyond the six-hour mark due to extenuating circumstances of potential or actual "vapor only" exposed CBRN SCBA. For example, the need to rescue and recover victims combined with a shortage of clean CBRN SCBA may support a decision to extend use of the CBRN SCBA units not exposed to liquid agent. This might be one example of the need to re-use vapor only exposed CBRN SCBA. The incident commander should determine at the 5.5 hour mark of a 6.0 hour CBRN SCBA use life plan, if the possibility of continued chemical warfare agent permeation or penetration is significant or if the ambient exposure has been substantially eliminated by immediate technical gross decontamination techniques conducted and decontamination confirmed by samples submitted to for public or federal health laboratory analysis. Examples of information links concerning emergency preparedness of public health laboratories are http://www.bt.cdc.gov/lrn/chemical.asp and http://www.aphl.org/Emergency_Preparedness/index.cfm. These information links and procedures emphasize the need for rapid and reliable CWA measurement techniques.

Expedient decontamination operations may maintain use life and allow additional use life time out of the same CBRN SCBA if vapor only conditions are known and the SCBA is expediently washed down after a given entry and exit. Furthermore, accurate detection is vital to isolating a specific number of contaminated respirators as opposed to isolating the entire shift of responder used respirators that might or might not have been contaminated above an available permissible exposure limit or other recognized occupational exposure limit for the given contaminant or contaminants. Since sulfur mustard (HD) agent toxicology and effects are highly persistent, modifications of the six-hour use statement in Caution and Limitation "U" is not recommended and therefore, not permitted when HD is the agent of exposure. Rapid decontamination techniques involving physical removal of HD contamination from the SCBA will decrease agent concentration, relative to agent contact time. This is why timely decontamination operations are important.

The use life of a CBRN SCBA after exposure to a CWA explicitly means **six continuous hours in a single shift, day, or event.** Therefore, the use life of a CBRN SCBA is not 6 individual 1-hour exposures in one shift or one day, nor does is it 6 different 1-hour exposures over the course of 6 different days. None of these example variations apply and other variations presented at the time of the incident response are also expected not to apply, if they deviate from the central use life theme of maintaining NIOSH CBRN protection approval for six continuous hours, beyond initial exposure.

CBRN SCBA USER GUIDANCE: BEFORE, DURING AND AFTER OPERATIONS ACTIONS

Trained first responders, emergency responders and first receivers routinely conduct pre-checks, in-process checks and post-checks of all issued and collective equipment used in route, on scene and off site. In an effort to categorize these actions into a user-friendly format relative to CBRN agent responses, information is outlined in this guide as before, during and after operations actions. This is recommended guidance to better support end user understanding, provide a written source for training purposes and a format for future NIOSH guidance documents. Manufacturer's user's instructions published at the time of issue of the CBRN SCBA have been consulted in the development of this guidance. This perspective has resulted in tailored guidelines describing CBRN SCBA use before operations, during operations, and after operations while integrating pertinent NIOSH CBRN SCBA cautions and limitations appropriately. Once CWA are contaminates, all use actions for CBRN SCBA are centered on the following 4 facts:

- **CBRN SCBA are single use**
- **CBRN SCBA have a maximum of six continuous hours of use life**
- **CBRN SCBA are decontaminated as expediently as possible prior to disposal to prevent the spread or penetration of contamination to other personnel or equipment**
- **All direct contact with CBRN agents require proper handling of the CBRN SCBA after each use and between multiple entries during the same use.**

In April, 2005, the EPA released a compilation of available data on building decontamination alternatives. In this document, the EPA discusses how a decontamination agent is registered with the agency, how it grants a crisis exemption allowing a specific decontamination agent to be used and types of liquids, foams, gels, gases and vapors the EPA has assessed as possible decontamination technologies for decontaminating buildings following an attack using chemical or biological agents [EPA, 2005]. Decontamination processes based on adjusted bleach pH have been demonstrated by the EPA as providing up to 6 logs of kill for biological agents with sufficient residence time on porous or hard surfaces. Six technologies are applicable to both chemical and biological agents while 5 additional technologies are specific to biological agent decontamination. See the EPA publication titled *Compilation of Available Data on Building Decontamination Alternatives*, Office of Research and Development, National Homeland Security Research Center, EPA, April, 2005.

The following links provide information concerning adjusted bleach pH decontamination and other advancing technologies:

http://www.fema.gov/txt/areyouready/areyouready.txt
http://ehp.niehs.nih.gov/members/1999/107p933-974munro/munro3.html
http://www.epa.gov/etv/verifications/testqa-index.html#bdt

CBRN SCBA INTEGRATION WITH PROTECTIVE SUIT ENSEMBLES

CBRN SCBA are NIOSH-approved as stand alone respiratory protection devices and not in tandem with any model or type of protective suit ensemble, overgarment or suit sub-component. Select industrial approvals may incorporate protective suits or suit components as industrial rated accessories but these are not CBRN approved. Protective suit ensembles used in hazardous waste operations (HAZWOPER) and hazardous materials (HAZMAT) emergency response operations, commonly known as Level A, Level B, Level C and Level D are recognized by OSHA to provide increasing levels of dermal and respiratory protection from liquid, aerosol and particulate contaminates, with Level A being the greatest amount of protection afforded. Per OSHA, Levels A and B, require that SCBA be used and are understood to provide higher levels of respiratory protection than levels C and D. Field use shows that modifications of those levels of protection do exist. A level C suit with a SCBA is common in law enforcement response operations. CBRN SCBA can be worn in Levels A or B and also are being worn with Level C ensembles. Crisis response incident commanders will not be regulated by OSHA in crisis response. They weigh the mission risk versus a given level of protection provided by equipment and should opt to use CBRN SCBA in Level C for a specific response because Level A or B are non-tactical or responders may not have Level A or B immediately available for time critical functions such as life saving or crime scene management.

The use of CBRN SCBA versus non-CBRN SCBA respirators with firefighter turn out gear, law enforcement field gear, OSHA/EPA Level A, B, C and D ensembles, NFPA 1994 Chemical/Biological Terrorism Incident class 1, 2 or 3 ensembles, or any other dermal protective barrier recognized by the U.S. Department of Homeland Security depends on the selection criteria used by an incident commander. Selection of respirator and protective suit ensemble combinations hinges on many variables, such as the environmental conditions of the site, whether the CBRN agent is unknown or known and whether the agent concentration can be characterized. Use of a non-CBRN/industrial SCBA with a Level A ensemble, while seeming practical, provide less respiratory protection in CBRN environments. If the Level A suit is compromised, the inside of that the suit will likely turn into an exposure chamber and warrant the increased respiratory protection that only a CBRN protected SCBA can provide. What to use, when to use it, how to use it and the underlying question of why are the types of use questions to answer prior to responding to a CBRN terrorism incident.

Currently, respirator manufacturers outfit SCBA with compatible accessories such as pass thru devices that support SCBA compatibility with protective suit ensembles and portable air sources. CBRN SCBA are equipped with rapid intervention team (crew)/universal air connection (RIT/UAC) accessories that support SCBA compatibility with protective suit ensembles and portable air sources. Use of the RIT/UAC or pass-thru device in an actual CBRN contaminated atmosphere is at the discretion of the incident commander or lead federal agency.

FUTURE GENERATION CONCEPTS

NIOSH offers CBRN protection approval for several other types of respirators. They are available as manufacturers gain NIOSH CBRN protection approval. They include the tight fitting, full-facepiece air-purifying respirators (APR) for emergency responders, a self-contained escape respirator (SCER) and air-purifying escape respirators (APER) for use by general working populations. Anticipated future respirator approvals will include the CBRN powered air-purifying respirators (PAPR), CBRN closed circuit SCBA and CBRN combination SCBA/air-purifying respirators.

NIOSH is continuing its efforts to publish special hazard CBRN use guides and intends to generate peer reviewed documents pertaining to various classes of CBRN approved respirators. These guides will utilize NIOSH public CBRN statement of standards as technical performance references.

APPENDIX A

Definitions and Glossary

Agent – A force or substance that causes change or effects on an exposed substrate, i.e., a chemical agent.

Airborne Exposure Guideline Level (AEGL) – Published by the National Research Council and Environmental Protection Agency, AEGL characterize the risk to the general population during a one-time accident and emergency scenario with time limits not to exceed eight hours. The AEGLs represent threshold exposure limits for the general public and are applicable to emergency exposure periods ranging from 10 minutes to eight hours (AEGL-1, AEGL-2, AEGL-3 and AEGL-4). AEGL are used by NIOSH for CBRN SCBA breakthrough criteria establishment.

Assigned Protection Factor (APF) – OSHA proposed rule, dated June 6, 2003, develops proposed APF and MUC definitions. This CBRN APF definition is an interim definition subject to the final OSHA ruling.

CBRN APF: CBRN APF is the level of protection that a respirator provides in the CBRN workplace determined by the known assigned protection factor for that respirator. The CBRN APF of 10,000 is a minimum anticipated, known or simulated workplace factor study level of protection value, expected by a properly functioning respirator, or class of respirators, to a percentage (95% or higher) of properly fitted and trained human test subjects. In accordance with OSHA 29 CFR 1910, 1915, and 1926, June 6, 2003, employers **must not** apply maximum use concentrations (MUCs) to conditions that are immediately dangerous to life or health (IDLH), instead, they **must use** respirators listed for IDLH conditions. The CBRN SCBA is a respirator listed for IDLH conditions, unknown conditions, less than IDLH conditions and escape from IDLH conditions. For those situations where exposures are quantified and known to be below IDLH or LEL quantified levels, maximum use concentration equations can be applied to respirators listed for less than IDLH conditions. The maximum use concentration (MUC) of exposure for a respirator is generally determined by multiplying a contaminant's occupational exposure limit (OEL) by the APF assigned to the specific class or type of respirator. The equation is MUC = OEL x APF. The maximum use concentration is the maximum ambient level of a hazardous substance in which employees can use the respirators [OSHA, 2003].

MUCs are effective only when the employer has a continuing, effective respiratory protection program as specified in 29 CFR 1910.134. The OSHA 29 CFR 1910, 1915 and 1926, June 6, 2003, proposed rule defers to respirator manufacturers when the manufacturer recommends a lower MUC for their respirators under specific hazardous substance conditions. An OEL can be a NIOSH recommended exposure limit (REL), an OSHA permissible exposure limit (PEL), a short term exposure limit, ceiling limit, peak limit, or any other recognized exposure limit for a hazardous substance.

The APF for a CBRN SCBA, under emergency conditions, is 10,000, provided QNFT is used to determine the fit factor. This is the traditional industrial SCBA APF. Translated this means the CBRN SCBA is capable of providing minimum respiratory protection against a contaminant concentration up to 10,000 times the exposure limit for that contaminant under emergency conditions. Additional experimentation is required to determine if a CBRN SCBA can be assigned a higher APF, due to the CBRN SCBA exhibiting much greater

resistance than an industrial SCBA to the direct application of GB and HD agents and offering a higher percentage of fitted human test subjects trials based on a 95th percentile LANL panel distribution of federal human test subjects tested against corn-oil particulate.

Biological Agents – Biological agents are bacteria, viruses, or toxins derived from biologic material. Airborne biological agents could be dispersed in the form of liquid aerosols or solid aerosols (a powder of bacterial spores, for example). Biological agents are classified according to biological type, use, operational effects, and physiological actions. Biological agents can be classified as pathogens, toxins, or other agents of biological origin, such as bioregulators or biomodulators.

Blister Agents (Vesicants) – Vesicants are highly reactive chemicals that combine with proteins, DNA, and other cellular components to result in cellular changes immediately after exposure or that are potentially delayed after exposure. The most commonly encountered clinical effects of blister agents include, dermal (skin erythema and blistering), respiratory (pharyngitis, cough, dyspnea), ocular (conjunctivitis and burns), and gastrointestinal (nausea and vomiting). Blister agents are H (sulfur mustard), HD (distilled sulfur mustard), nitrogen mustard (HN-1, HN-2, HN-3) and Lewisite (L, L-1, L-2, L-3).

Bunker Gear/Turnout Gear/Fire Fighter Protective Ensemble (FFPE) – Protective clothing for structural firefighters that is designed to protect against the thermal environments experienced during structural firefighting. Usually consisting of a jacket and trousers, bunker gear is not appropriate for proximity firefighting. Additionally, bunker gear is not a recognized ensemble for full protection against CBRN agents. Expedient use of bunker gear, with fire helmet, CBRN SCBA, fire gloves and fire boots, to escape from CBRN contamination or an ensuing CBRN incident, is a field expedient form of protecting fire emergency responders from the respiratory hazards of a CBRN incident, but is not considered by NIOSH, as an example of a protective ensemble that provides appropriate levels of protection against dermal hazards of CBRN agents, as stated in NIOSH CBRN Caution and Limitation "Q".

CASARM Grade Agent– Chemical Agent Standard Analytical Reference Material (CASARM) grade agent is the type of chemical warfare agent required by NIOSH for certification of respirator performance against GB and HD special CBRN test requirements. Chemical material storage sites and agent manufacturers manage a CASARM program that relies on repeatable documentation that supports a certification of purity by agent lot numbers per produced quantity of agent. The certified purity program uses proven analytical methodology, such as acid-base titration, to certify the purity of a lot number of CASARM grade chemical warfare agent. An example of a CASARM grade certification of purity is as follows: *CASARM grade Sarin (GB) (Lot # GB-U-6814-CTF-N) had a certified purity of 98.7 +/- 1.9 wt % of GB as determined by acid-base titration.* Impurity % of the CASARM grade agent can be based on mole ratios from acid-base titration or other equivalent methods. Munitions grade chemical warfare agents are and example of a non-CASARM grade agent and are usually distilled products.

CBRN – A NIOSH-approved protection meaning chemical, biological, radiological, nuclear agents and required to be listed on the NIOSH label for a CBRN SCBA or other approved classes of respirators. Specific CBRN cautions and limitations apply once the respirator is prepared and used for CBRN incident response. Other examples of a NIOSH-approved protection are "SC" for Self-Contained and "PD" for Pressure-Demand. These protection categories are listed sequentially together in the protection column of a NIOSH label as follows: *SC/PD/CBRN 60 min 4500 psig*. The protection category assists responders in determining

what types of protections are available from a specific respirator manufacturer when incident site logistics programs require assistance in determining the types of compatible cylinders and hardware on site.

CBRN Self Contained Breathing Apparatus (SCBA): An Open Circuit, Pressure-Demand, Entry and Escape SCBA –The CBRN SCBA are atmosphere-supplying respirators with an integral breathing air source designed to be carried by the user and a full-face, tight fitting facepiece, with or without approved accessories on a SCBA, found compliant to NIOSH 42 CFR 84, the NFPA 1981 standard/code, and NIOSH CBRN special tests. The CBRN SCBA is required to display the NIOSH *CBRN Agent Approved* adhesive label on the back frame.

Chemical Warfare Agents (CWA) – Chemical warfare agents are agents specifically intended for military warfare operations to kill, seriously injure or incapacitate people. In the context of the CBRN SCBA cautions and limitations "*T*" and "*U*" pertains to equipment contamination. The chemical warfare agents are nerve agents: GB (Sarin), GA (Tabun), GD (Soman), GF (cyclohexyl Sarin), and VX; and blister agents: H (sulfur mustard), HD (sulfur mustard), nitrogen mustard (HN-1, HN-2 and HN-3) and Lewisite (L, L-1, L-2 and L-3).

Class 1 Ensemble, NFPA – *Note: As of 2005, this NFPA ensemble level is up for revision by NFPA.* In accordance with *NFPA 1994 Standard on Protective Ensemble for Chemical/Biological Terrorism Incidents, 2001 Edition*, Class 1 ensembles offer the highest level of protection. Class 1 ensembles are intended for the worst-case circumstances, where the substance involved creates an immediate threat, is unidentified, and of unknown concentration. Such situations may exist under three scenarios: where there is still an on-going release with likely exposure, the responder is close to the point of release, or most victims in the area appear to be unconscious or dead from exposure. Stay times in the hazard zone are likely to be very short and limited to the breathing air available from the CBRN SCBA. *Note: NFPA 1994, 2001 edition, is under revision at the time of publication.*

Class 2 Ensemble, NFPA – In accordance with NFPA 1994 Standard on Protective Ensemble for Chemical/Biological Terrorism Incidents, 2001 Edition, Class 2 ensembles offer an intermediate level of protection. Class 2 ensembles are intended for circumstances where the agent or threat has generally been identified and where the actual release has subsided. Conditions of exposure include possible contact with residual vapor or gas and highly contaminated surfaces at the emergency scene.

Class 3 Ensemble, NFPA – In accordance with NFPA 1994 Standard on Protective Ensemble for Chemical/Biological Terrorism Incidents, 2001 Edition, Class 3 ensembles offer the lowest level of protection. Class 3 ensembles are intended for use well after the release has occurred or in the peripheral zone of the release scene for such functions as decontamination, patient care, crowd control, and clean-up. Class 3 ensembles should only be used when there is no potential for vapor or gas exposure and exposure to liquids is expected to be incidental through contact with contaminated surfaces. Class 3 ensembles must cover the individual and it is preferred that this clothing also cover the wearer's respirator to limit its potential for contamination. Because these ensembles are intended for longer wear periods, the use of air-purifying respirators with these suits is likely.

Cold Zone/Green Zone/Clean Zone – The cold zone is an uncontaminated area where workers are unlikely to be exposed to hazardous substances or dangerous conditions. This is the area where the command post and

support functions that are necessary to control the incident are located. This is also referred to as the clean zone, green zone or support zone in other documents.

Contaminated – "Contaminated" is an adjective that describes the known condition of an item of personal protective equipment, such as a CBRN contaminated SCBA. If the item is said to be CBRN "contaminated," it is understood that it has been or is being exposed to the deposit, absorption or adsorption liquid, vapor, aerosol or particulate chemical, biological, radiological or nuclear agent/effects or byproducts of CBRN waste. The CBRN persistent contamination is still present, off gassing, or traces of a non-persistent CBRN agent are still possible. This condition is normally attributed to active use in known CBRN response environments, but it may also occur as a result of contamination transfer from a dirty/contaminated item of PPE to a clean item of PPE. A contaminated CBRN SCBA must be handled, decontaminated, and disposed of in accordance with the NIOSH CBRN SCBA cautions and limitations "I, J, M, N, O, S, Q, R, T, and U". CBRN respirator 6-hour continuous use life limitation (CRUL = 6) applies when the exposure is to any of the listed chemical warfare agents.

Decontamination – A simplified or complex process intended to make PPE safe for continued use, limited re-use or disposal by decreasing the amount of contamination on an object, or area through the actions of absorption, neutralization, detoxification, destruction, aeration/ventilation, or physical removal of known or suspected contamination. Compounds that are used for decontamination are known as decontamination agents.

Dirty Bomb – A conventional explosive device surrounded by or contaminated with some form of radioactive material and designed or intended to disperse the radioactive isotopes upon detonation.

Encapsulated Ensemble – The encapsulated ensemble provides liquid-tight, vapor-tight, and/or gas-tight protection depending on design and compliance testing. The elements of an encapsulating ensemble are garments, hoods, gloves, and footwear that provide protection to the upper and lower torso, head, hands, and feet and completely cover the wearer and the wearer's SCBA or supplied air respirator. OSHA describes it as a totally-encapsulated chemical protective suit (TECP suit) and defines it as a full body garment constructed of protective clothing materials. Materials that cover the wearer's torso, head, arms and legs at a minimum may also cover the wearer's hands and feet with tightly attached gloves and boots. This completely encloses the wearer and his/her assigned respirator provided there is a seamless interface between the respirator and the protective suit ensemble head material. CBRN SCBA provides respiratory protection to users in an encapsulated ensemble.

Event of National Significance— Major events, as determined by the President of the United States, that are vulnerable to terrorism and other criminal acts.

Exposure – The act or instance of exposing PPE or the human respiratory system to direct CBRN agents or their effects by removing protection, or the protection being compromised as a result of being subject to some detrimental effect or harmful condition such as CBRN contamination. Being contaminated does not mean you are necessarily exposed.

Emergency Responder/Emergency Response Provider – Per the DHS, emergency responder or emergency response provider includes federal, state, local, and tribal emergency public safety, law enforcement,

emergency response, emergency medical, including hospital emergency facilities, and related personnel, agencies, and authorities.

First Responder – Per the DHS, local and nongovernmental police, fire and emergency personnel who, in the early stages of an incident, are responsible for the protection and preservation of life, property, evidence, and the environment, including emergency response providers as defined in Section 2 of the Homeland Security Act of 2002, as well as emergency management, public health, clinical care, public works, and other skilled support personnel, such as equipment operators, who provide immediate support services during prevention, response, and recovery operations. First responders may include personnel from federal, state, local, tribal or nongovernmental organizations.

Fit Factor – A quantitative estimate value of the fit of a specific respirator facepiece to a specific individual and typically estimates the ratio of the concentration of a substance in ambient air to its concentration inside the respirator when worn properly.

Fit Test – The use of a specific measurement protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual. See also qualitative fit test (QLFT) or quantitative fit test (QNFT).

HAZMAT Team – A hazardous materials response team organized and designated by the employer, that is expected to perform work to handle and control actual or potential leaks or spills of hazardous materials requiring possible approach to the substance. The team members perform responses to releases or potential releases of hazardous substances for the purpose of control or stabilization of the incident. A HAZMAT team is not a fire brigade nor is a typical fire brigade a HAZMAT team. A HAZMAT team, however, may be a separate component of a fire brigade or fire department. HAZMAT teams are expected to be follow-on responders or first responders to a CBRN incident.

Hot Zone/Red Zone – An exclusion zone, designated as an administrative area, surrounding a dangerous goods incident, and designed to be an all-encompassing zone signifying highest hazardous contamination or situation of the site, and extending far enough in a determined or flexible distance to prevent any immediate adverse effects from contamination on personnel downwind or adjacent to the zone. The hot/red zone is the innermost exclusion zone of a three-layered administrative zone system. They involve hot, warm and cold zones/red, yellow and white zones, that provide administrative controls for CBRN contamination detection, site stabilization, crime scene evidence recovery, contamination containment, contamination mitigation, contaminate decontamination and site evacuation/shelter in place, command and control and logistics re-supply operations. Entry is controlled and proper PPE is required to operate in the red zone. This zone is also referred to as an exclusion zone, hot zone, or restricted zone. Historically, there is precedence that the actual use of the term "hot zone" or "hot lab" applies to biological contagions only.

Preston [1994], McCormick et al. [1996]. For the purposes of this document, hot zone includes all hazards of CBRN agents, whether they are independent or multiple.

Incident Command System (ICS) and Incident Commander (IC) – A system and command designate for managing emergencies.

Immediately Dangerous to Life or Health (IDLH) – Conditions that pose an immediate threat to life or health or conditions that pose an immediate threat of severe exposure to contaminants, such as radioactive materials, which are likely to have adverse cumulative or delayed effects on health. (See Section H: Other Hazardous Atmospheres in Chapter 2 for more information on IDLH conditions).

Laboratory Respirator Protective Level (LRPL) Testing – A NIOSH-approved CBRN respirator certification test using human test subjects to ensure that the facepiece seal interface between the test subject and the SCBA performs to an established protection level in a quantified laboratory chamber filled with a specific amount of corn-oil aerosol particulates. The LRPL test is conducted using 11 exercise movements on a Los Alamos National Laboratory panel of facepeice sizes for human test subjects, which approximates the facial shapes and sizes of the user population at the 95th percentile.

Level A Ensemble/Protection – The EPA personal protective equipment ensembles identified as Level A, B, C, or D are based on their levels of protection. These ensembles are listed in Appendix B of the OSHA HAZWOPER Standard 29 CFR 1910.120, and in the *NIOSH Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* (1985). **Level A** represents the greatest danger of respiratory, eye or skin damage from hazardous vapors, gases, particulates, sudden splash, immersion or contact with hazardous materials. A Level A ensemble consists of total encapsulation in a vapor tight chemical suit with self-contained breathing apparatus (SCBA) or supplied air and appropriate accessories.

Level B Ensemble/Protection – The EPA personal protective equipment ensembles identified as Level A, B, C, or D are based on their levels of protection. These ensembles are listed in Appendix B of the OSHA HAZWOPER Standard 29 CFR 1910.120 and in the *NIOSH Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* (1985). **Level B** situations call for the highest degree of respiratory protection but a lesser need for skin protection. It calls for SCBA or positive pressure supplied air respirator with escape SCBA, plus hooded chemical resistant clothing (overalls and long sleeved jacket, coveralls, a one or two piece chemical-splash suit; or disposable chemical-resistant coveralls).

Level C Ensemble/Protection – The EPA personal protective equipment ensembles identified as Level A, B, C, or D are based on their levels of protection. These ensembles are listed in Appendix B of the OSHA HAZWOPER Standard 29 CFR 1910.120 and in the *NIOSH Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* (1985). Level C protection should be selected when the type of airborne substance is known, concentration measured, criteria for using air-purifying respirators met, and when skin and eye exposure is unlikely. Periodic monitoring of the air must be performed. Level C ensembles include a full-face or half-mask, air-purifying respirator, chemical resistant clothing (one piece coverall, hooded two piece chemical splash suit, chemical resistant hood and apron, disposable chemical resistant coveralls), and gloves and boots.

Level D Ensemble/Protection – The EPA personal protective equipment ensembles identified as Level A, B, C, or D are based on their levels of protection. These ensembles are listed in Appendix B of 29 CFR 1910.120 and in the *NIOSH Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* (1985). Level D is primarily a work uniform and is used for nuisance contamination only. It requires only coveralls and safety shoes/boots. Other PPE is worn based upon the situation (types of gloves, etc.). It should not be worn on any site where respiratory or skin hazards exist.

Levels of Protection – Refers to the levels of respiratory and dermal (skin) protection that an ensemble provides such as Level A, Level B, Level C or Level D. A level of protection refers to both the clothing and the respiratory devices. These levels are defined by OSHA as it relates to respiratory protection and are accepted by response organizations such as the U.S. Coast Guard and the EPA.

Live Agent Test (LAT) – Common term used to describe a CBRN respirator certification test that measures CWA permeation and penetration resistance against actual or "live" Sarin vapor and aerosol (GB) or sulfur mustard (HD) liquids, vapors and aerosol. GB LAT or HD LAT describes the phase of testing the respirator is in or has completed.

Maximum Use Concentration (MUC) – The maximum atmospheric concentration of a hazardous substance from which an employee can be expected to be protected when wearing a respirator. It is determined by the assigned protection factor of the respirator or class of respirators and the exposure limit of the hazardous substance. The MUC usually can be determined mathematically by multiplying the assigned protection factor (APF) specified for a respirator by the NIOSH recommended exposure limit (REL), permissible exposure limit, short term exposure limit, ceiling limit, peak limit, or any other exposure limit used for the hazardous substance. Use of MUC is for less than IDLH.

National Institute for Occupational Safety and Health (NIOSH)/The Institute – NIOSH is the federal agency responsible for conducting research and making recommendations for the prevention of work-related injury and illness. NIOSH is part of the Centers for Disease Control in the Department of Health and Human Services.

National Personal Protective Technology Laboratory (NPPTL) – Part of NIOSH, the mission of NPPTL is to prevent work-related injury and illness by ensuring the development, certification, deployment, and use of personal protective equipment and fully integrated intelligent ensembles. NPPTL operates the national certification program for civilian respirators used in all types of workplace environments.

CBRN Approved – A NIOSH certification term that signifies that specific respirator systems have been evaluated, reviewed, and approved/certified by NIOSH and provide an acceptable level of protection against chemical, biological, radiological, and nuclear agents. Approval authority authorized by the existing policy of 42 Code of Federal Regulation, Part 84 (42CFR84) and the statement of standard that utilizes the three-tier approval process for issuing a CBRN protection approval for a SCBA.

NIOSH-Approved – It is a term that describes a respirator system and its accessory components that have been reviewed and certified by NIOSH in accordance with 42 CFR Part 84 and determined approved for use by the general public in defined workplaces. Approval authority is derived by 42 CFR Part 84 to provide coverage for industry and, therefore, issued approvals are in support of OSHA.

Nerve Agents – Nerve agents consist of a group of very toxic organophosphate chemicals specifically designed for military warfare. Nerve agents are GB (Sarin), GA (Tabun), GD (Soman), GF (Cyclohexyl Sarin), and VX. Nerve agents cause effects on the human body by disrupting how nerves communicate and control muscles, glands, and organs.

NFPA 1981 Standard – Standard on Open Circuit Self-Contained Breathing Apparatus for Fire Fighters and Emergency Services Personnel. Updated every 5 years, it is part of the second tier of approval for the CBRN SCBA. The 1981 edition in effect, at the time of CBRN approval letter, is the edition under which the CBRN SCBA must demonstrate code compliance.

NFPA 1991 Standard – National Fire Protection Association Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies. The NFPA 1991 vapor protective ensemble provides a minimum level of protection against adverse chemical vapor, liquid splash, and particulate environments during hazardous materials emergency incidents. Optional test criteria is available for chemical flash fire escape protection, liquefied gas protection, and chemical/biological terrorism agent protection (chemical/biological terrorism agent protection is also addressed in the NFPA 1994 standard).

NFPA 1994 Standard – National Fire Protection Association Standard on Protective Ensembles for Chemical/Biological Terrorism Incidents. The NFPA 1994 Standard on Protective Ensemble for

Chemical/Biological Terrorism Incidents (current 2001 Edition) sets performance requirements for protective clothing used at chemical and biological terrorism incidents. It defines three levels of ensembles (Class 1, Class 2, and Class 3) based on the perceived threat. The differences between the three classes are based the ability of the clothing design to resist the inward leakage of chemical or biological contaminants, the resistance of the materials used in the ensembles to chemical warfare agents and toxic industrial chemicals, the strength and durability of these materials. Ensembles are designed for a single exposure use, and consist of garments, gloves, and footwear. The NFPA 1994 Class designations should not be viewed as being equivalent to the OSHA protective clothing designations of Level A, B, C.

Non-encapsulated Ensemble – A type of liquid splash-protective ensemble that does not provide liquid-tight, vapor-tight, or gas-tight protection to the wearer. The respirator is fully exposed except for those portions that may be covered by the ensemble hood.

Non-Persistent – A common term used to describe the generally understood short duration time a chemical agent or any CBRN agent, remains on the target or in the area.

Oxygen Deficient Atmosphere – An atmosphere which contains an oxygen partial pressure of less than 148 millimeters of mercury (19.5 percent by volume at sea level).

Persistent – A common term used to describe the generally understood long duration time chemical agent or any CBRN agent, remains on the target or in the area. All factors such as weather, concentration, physical state, surface contaminated, and temperature should be considered in determining if a CBRN agent is in fact persistent and capable of presenting a long term hazard to responders.

Nuclear Agents – Particulate-borne radiation dispersed by detonation of an improvised nuclear device (IND) or high/low yield nuclear detonation. An IND could consist of diverted nuclear weapon components or a modified nuclear weapon. INDs require fissionable material—highly enriched uranium or plutonium—to produce nuclear yield.

Penetration – The act or process of penetrating, piercing, or entering. As it relates to CBRN testing, it is a term that means exposing the respirator to specific quantities of chemical warfare agent with the express intent of determining if the agent is prevented from permeating or penetrating the air pressure boundaries or material interfaces into the breathing zone of the respirator. If it penetrates under laboratory ideal conditions, most likely it will penetrate under confined space or enclosed space exposure conditions.

Permeation – The action of passing through the openings or interstices of a substrate at the surface level or the molecular level. As it relates to CBRN testing, it is a term that means exposing the respirator to a specific quantity of chemical warfare agent with the express intent of determining if the agent is stopped and runs off, or if it beads up and starts to permeate through air pressure boundaries or material surfaces into the breathing zone of the respirator or respirator accessories. If the agent permeates under laboratory ideal conditions, most likely it will permeate under confined space or enclosed space exposure conditions.

Permissible Exposure Limit (PEL) - An enforceable regulatory limit set by the Occupational Safety and Health Administration (OSHA) on the amount or concentration of a substance in the air. PELs are set to protect workers against the health effects of exposure to hazardous substances and are based on an 8-hour time weighted average exposure.

Personal Protective Equipment (PPE) – Clothing and equipment used to shield or isolate individuals from the chemical, physical, and biological hazards that may be encountered at a hazardous waste-site. PPE should protect the respiratory system, skin, eyes, face, hands, feet, head, body, and ears.

Positive Pressure Respirator – A respirator in which the pressure inside the respiratory inlet covering exceeds the ambient air pressure outside the respirator.

Protective Suit Ensemble – The complete personal protective equipment outfit (i.e., respirator, gloves, boots, clothing, etc., required for an event or task.

Radiological Agents – Particulate-borne radiation dispersed by detonation of a radiological dispersive device (RDD) or "dirty bomb."

Rapid Intervention Crew /Company Universal Air Connection System (RIC UAC) – A portable compressed air system consisting of compatible interfaces that allows emergency replenishment of breathing air to the SCBA for down, disabled, or entrapped emergency responders.

Rapid Intervention Team/Crew (RIT) – Designated firefighter search & rescue teams.

Rated Service Time – A manufacturer assigned value and a NIOSH-approved rated time of duration assigned based on breathable air that a respirator uses linked to air consumption at a moderate work rate.

Recommended Exposure Limit (REL) – An occupational exposure limit recommended by NIOSH that protects of worker health and safety over a working lifetime. RELs are time-weighted average concentrations for up to a 10-hour workday during a 40-hour workweek.

Refugee Staging Area/Area, Staging, Refugee (RSA) – Area where suspected or actual contaminated personnel are isolated away from the CBRN contamination source. RSA is in the red zone but upwind of the source and allows for contaminated personnel to get out of contamination but not out of the red zone.

Respirator Protection Program – A written procedure used to ensure that respirators are properly selected, used, and maintained by identified personnel. The program is to be administered by a suitably trained administrator and the program elements must meet the criteria specified in the OSHA respiratory protection standard (29 CFR 1910.134).

Terrorism – Per the Department of Homeland Security National Response Plan, it is any activity that (1) involves an act that (a) is dangerous to human life or potentially destructive of critical infrastructure or key resources; and (b) is a violation of the criminal laws of the United States or of any State or other subdivision of the United States; and (2) appears to be intended (a) to intimidate or coerce a civilian population; (b) to influence the policy of a government by intimidation or coercion; or (c) to affect the conduct of a government by mass destruction, assassination or kidnapping.

Toxic Industrial Chemicals (TICs)/Toxic Industrial Materials (TIMs) – a variety of chemicals used in various routine industrial processes which can, if inadvertently or deliberately released, possibly kill, seriously injure, or incapacitate people.

User's instructions (UI) – A NIOSH recognized manufacturer publication required to be submitted to NIOSH as part of a certification application requesting NIOSH approval. The UI are included with every new purchase of a NIOSH approved respirator.

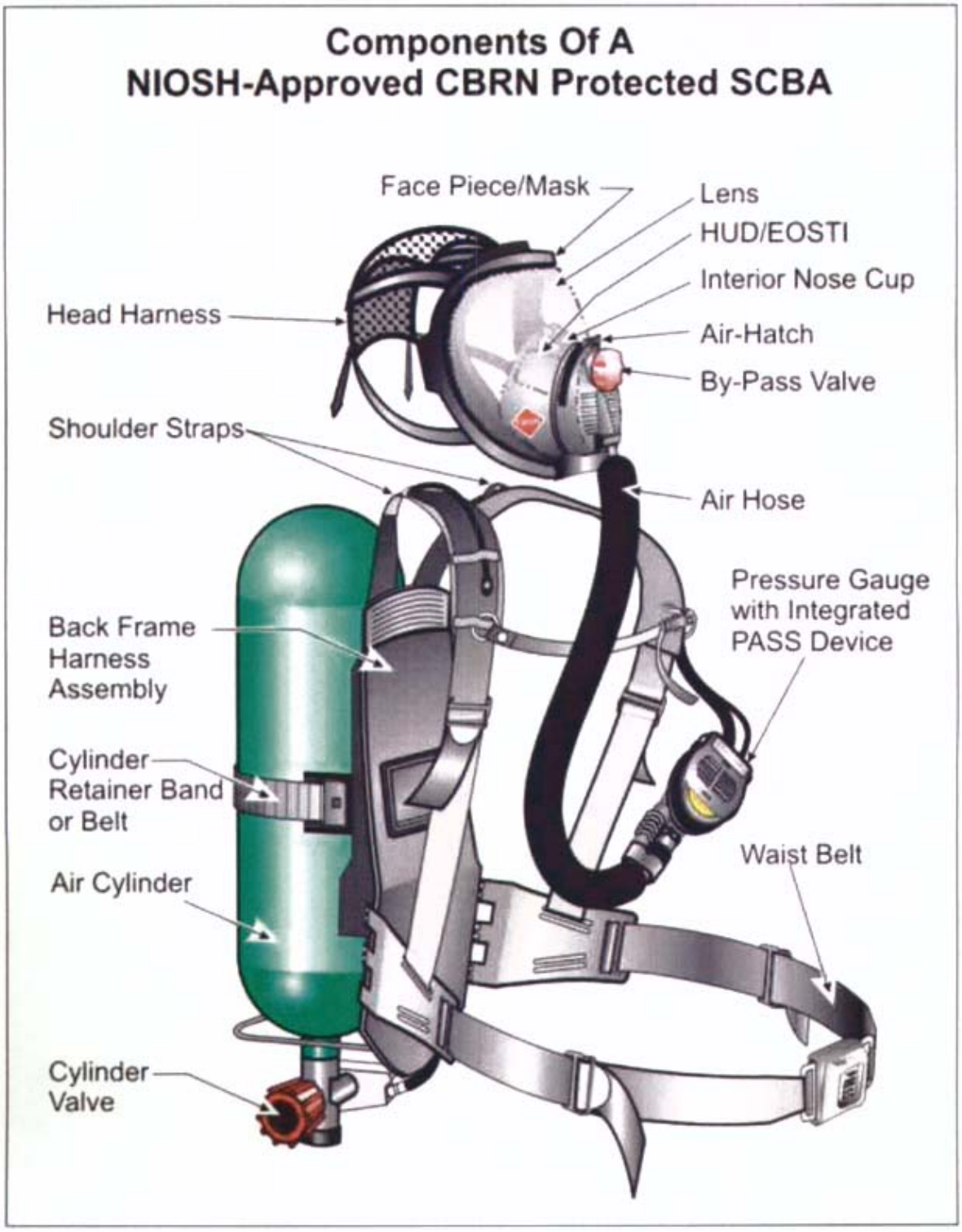
User Seal Check - An action conducted by the respirator user to determine if the respirator is properly seated to the face.

Use Life/CBRN Respirator Use Life Time Value (CRUL) - Use limitation applying to the CBRN SCBA of a continuous 6-hour period beginning at the time of a confirmed exposure to a chemical warfare agent, after which the CBRN SCBA must be decontaminated and disposed of properly. Some variations on this rule are possible based on life saving priorities of the incident commander or other authority commanding operations at the event site.

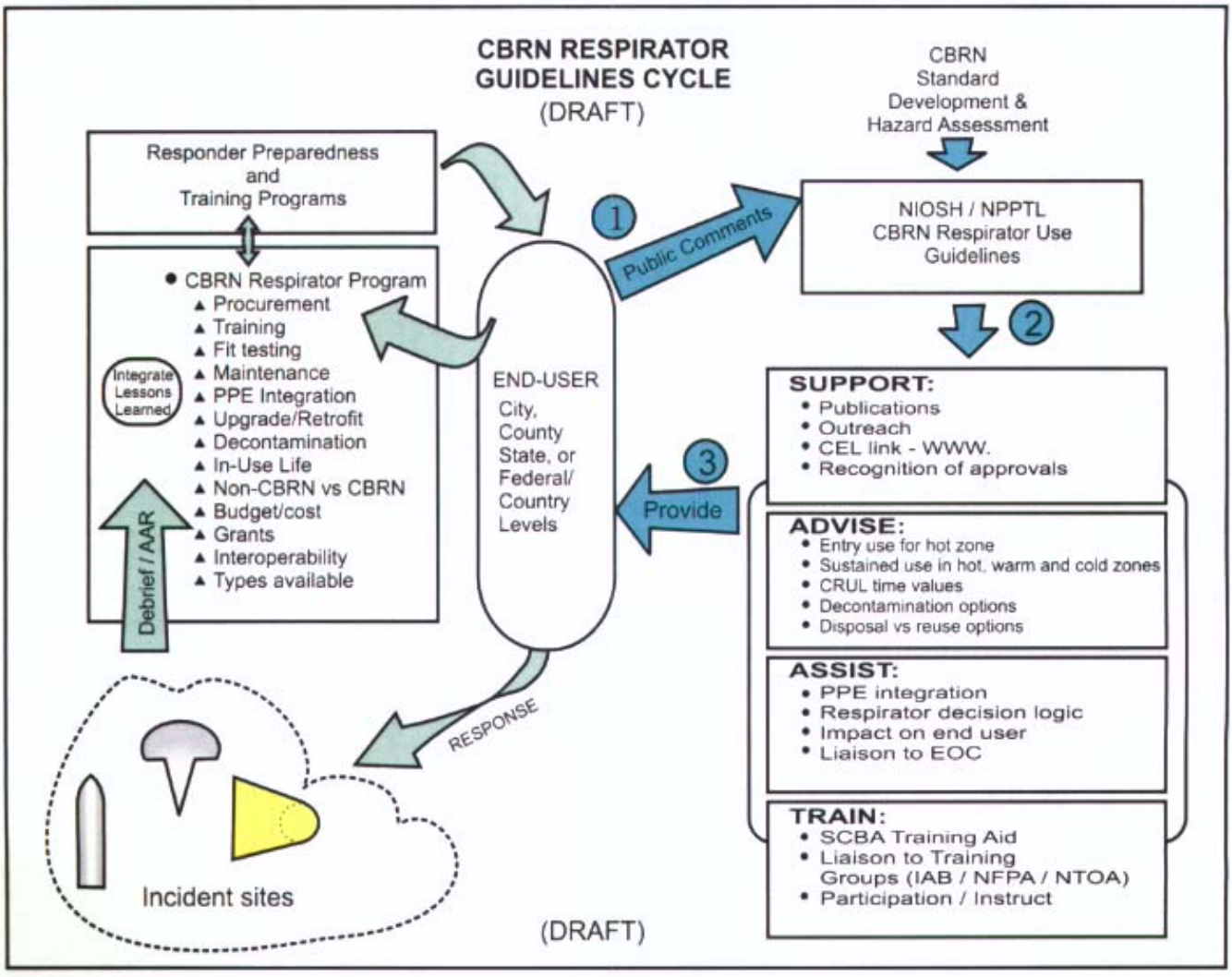
Warm Zone/Yellow Zone/Decontamination Zone— Area between hot and cold zones where personnel and equipment decontamination and hot zone support take place. It includes control points for the access corridor and thus assists in reducing the spread of contamination. Also referred to as the contamination reduction corridor (CRC), contamination reduction zone (CRZ), yellow zone or limited access zone in other documents.

Weapon of Mass Destruction - As defined by Title 18, U.S.C. 2332a: (1) Any explosive, incendiary, or poison gas, bomb, grenade, rocket (having a propellant charge of more than 4 ounces), missile, mine, or similar device (having an explosive or incendiary charge of more than one-quarter ounce); (2) Any weapon that is designed or intended to cause death or serious bodily injury through the release, dissemination, or impact of toxic or poisonous chemicals or their precursors; (3) Any weapon involving a disease organism; or (4) Any weapon that is designed to release radiation or radioactivity at a level dangerous to human life.

APPENDIX B



APPENDIX C



APPENDIX D

Frequently Asked Questions (FAQ)

1. Is it always necessary to perform a "user seal check" on a CBRN SCBA respirator before each use?

Yes. In order to attain the proper designed seal to your face each time you don the facepiece, you should perform the manufacturer suggested user seal check/facepiece fit check. If this is not done every time, you risk entrapping contaminants, breathing contaminants or depleting the air source. Do not confuse a user seal check with a fit test. A user seal check is done by the wearer immediately after donning the SCBA facepiece to ensure a proper seal is attained prior to entering a given workplace requiring respiratory protection. User seal checks, also known as facepiece fit checks, and thus the confusion with the terms fit test, are also done if the user detects facepiece misalignment or cool air as a result of extended wear of the respirator or jarring of the facepiece while being worn. Whereas, a fit test is a qualitative or quantitative respirator performance test done with a selection of respirators on a human subject and by the respirator program administrator or a designated qualified individual. Performing a user seal check before entering a contaminated area is important to minimize contaminant leakage into the facepiece and to minimize leakage out of the facepiece that wastes air and reduces service time. User seal check procedures are located in Appendix B-1 of the OSHA Respiratory Protection Standard [29 CFR 1910.134]. Equally effective manufacturer's user seal check procedures, which are located in the manufacturer's user's instructions specific to the model of respirator, are also acceptable. The OSHA procedures are located at:
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9781

2. How do I tell the difference between a NIOSH-approved CBRN SCBA and a NIOSH-approved SCBA, which is not approved for CBRN protection?

Look to see if the CBRN Agent Approved label shown below is on the respirator harness assembly. If a respirator is CBRN-approved by NIOSH, it will carry this adhesive label. The label is required to be located on the back frame of the SCBA in a highly visible location. If this CBRN Agent Approved label is **not** on the SCBA, the device is **not** approved by NIOSH for use in CBRN environments. **Check the CBRN Agent Approved label!** The label may also contain the word 'Retrofit' denoting that the SCBA was a previously deployed traditional industrial NIOSH approved non-CBRN SCBA which has been upgraded to CBRN protection status.

The font size of the NIOSH label may vary between SCBA manufacturers and the exact location of the label on the harness assembly is also at the discretion of the manufacturer. CBRN SCBA may also have unique markings for specific manufactured production models which are voluntarily designated by the manufacturer. These unique markings, if present, are not required for NIOSH approval, but are provided for the benefit of the user to distinguish CBRN protected SCBA from non-CBRN protected models in the same workplace. Unique markings can consist of color-coded adhesive labels prominently displayed on visible components of the CBRN SCBA, use of the printed letters 'CBRN' to identify second stage regulators, use of the letters CBRN on the side of the backframe, or use of the letters CBRN inside the facepiece or embossed facepieces.

3. Will a NIOSH approved SCBA that is not approved with CBRN protection protect me from CBRN agents? Do I have to use a NIOSH-approved CBRN SCBA in a CBRN response?

A NIOSH approved SCBA that is **not** CBRN approved (referred to as an industrial or traditional NIOSH approved SCBA) has not been tested for penetration and permeation resistance to chemical warfare agents as part of its NIOSH approval. Because many chemical warfare agents (CWA) are highly aggressive in terms of their penetration and permeation ability, the traditional non-CBRN SCBA should not be relied on to provide protection against chemical warfare or terrorism agents. For protection against CWA gas/vapors and liquid contact, a CBRN SCBA should be used. The traditional non-CBRN SCBA should be limited to use to for protection against industrial exposures.

The traditional industrial non-CBRN SCBA provides industrial levels of protection against industrial gases, vapors and particulate aerosols including biological (bacteria and viruses) and radiological and nuclear particulate aerosols. The traditional industrial SCBA also provides protection against unknown industrial atmospheres, industrial IDLH conditions, and oxygen deficient industrial atmospheres.

4. Do I need to dispose of my NIOSH approved CBRN SCBA after use in a chemical warfare agent (CWA) contaminated environment?

Yes. Following use in an environment with the confirmed presence of chemical warfare agents (CWA) including GB, GA, GD, GF, VX, HD, HN-1, HN-2 and HN-3 and Lewisite in liquid, aerosol or vapor forms, the NIOSH approved CBRN SCBA must be removed from service and disposed of properly following **6 continuous hours** after the initial confirmed exposure. The SCBA should not be reused following this 6 hour time period and should be decontaminated and disposed of in a manner that is consistent with the type of contamination and any government regulations governing decontamination of contaminated items. Some variations on the 6-hour use-life rule are possible at the discretion of the response scene incident commander or other appropriate authority and are discussed in this document in Chapter 6.

After use in an environment that **does not** contain CWAs, the respirator should be cleaned in accordance with recommendations from the manufacturer and current Centers for Disease Control and Prevention decontamination protocols.

5. How long can I use my NIOSH CBRN SCBA at the scene of a response?

The CBRN SCBA respirator should not be used beyond **six-continuous hours** after an initial confirmed chemical warfare agent (CWA) exposure in liquid, vapor or aerosol form to avoid possibility of agent permeation or penetration. Following the 6 continuous hour time period, the SCBA should be decontaminated and disposed of in a manner that is consistent with the type of contamination and any government regulations governing contaminated items. Some variations on this rule are possible and are discussed in this document in Chapters 5 & 6. If no CWAs are present, the SCBA should be used in accordance with the manufacturer's user recommendations for inspection, cleaning, and maintenance. If the SCBA was used in a response involving biological or radiological contamination, the SCBA will need to be decontaminated in accordance with manufacturer guidance and recommended CDC decontamination methods before reuse.

6. Where can I find a list of NIOSH approved CBRN SCBA?

A list of currently approved CBRN SCBA is available on the NIOSH, NPPTL web site at: http://www.cdc.gov/niosh/npptl/topics/respirators/cbrnapproved/scba/

7. Where are the user's instructions specific for my CBRN SCBA model?

Every NIOSH approved CBRN SCBA is sold with a printed copy of the manufacturer's user's instructions plus a NIOSH CBRN SCBA label insert. If you do not have a printed copy of the manufacturer's user's instructions contact the manufacturer or equipment supplier to obtain a current copy. Integration of CBRN related user's instructions is at the discretion of the manufacturer. NIOSH is available to assist in locating correct user's instructions.

8. What hazards does the CBRN SCBA protect against? Which chemicals and particles, and at what levels?

Note: Read Chapter 2, Design Requirements and Components, for a detailed explanation of protection provided by a NIOSH approved CBRN SCBA.

- *Airborne industrial chemicals*—Chemicals used in industrial applications existing in the airborne states of gases, vapors, and solid and liquid particulate aerosols.
- Specific *chemical warfare agents*—Protection is provided against GB (Sarin), GA (Tabun), GD (Soman), GF (Cyclohexyl Sarin), VX, HD (sulfur mustard), nitrogen mustard (HN-1, HN-2 and HN-3) and/or Lewisite (L, L-1, L-2 and L-3)
- *Particulate aerosols*—Solid or liquid chemicals that are suspended in air. This includes protection against biological aerosols (bacteria and viruses), colloidal suspensions and particulates carrying radioactive isotopes.
- *Unknown atmospheres*—Atmospheres where the types of contaminants and their concentrations are unknown within the limitations of the SCBA.
- *IDLH atmospheres*—Atmospheres where the contaminant concentrations are known to be immediately dangerous to life or health (IDLH) within the limitations of the SCBA.
- *Oxygen deficient atmospheres*—Atmospheres known to contain less than 19.5% oxygen at sea level within the limitations of the SCBA.

9. How do I know if the facepiece is properly sealed to my face so that I am protected?

You know this by conducting a correct user seal check that confirms the air tight seal interface between a correctly fitted and donned respirator and the physical dimensions of your clean shaven face. You should feel a slight vacuum pressure or overpressure when the negative or positive pressure user seal check is done so that no strange odors or sensations are detected while breathing normally with the sealed respirator. With CBRN SCBA, fit testing is routinely performed with special emphasis on maintaining serviceability of unique materials and components that make the SCBA CBRN compliant. This is normally done by adapting the SCBA facepiece to a negative pressure configuration and conducting quantitative fit testing with a calibrated fit test machine. Under OSHA, the respirator program administrator is responsible for managing the workplace respirator protection program and providing fit-tests to respirator users prior to initial use of the

respirator, whenever a different respirator facepiece (size, style, model or make) is used, and at least annually thereafter to ensure continued, proper fit [29 CFR 1910.134(f)(2)]. Users should also undergo fit testing when changes in their physical condition could affect respirator fit. Such conditions include, but are not limited to, facial scarring, dental changes, cosmetic surgery, or an obvious change in body weight [29 CFR 1910.134(f)(3)]. The OSHA Respiratory Protection Standard [29 CFR 1910.134] mandates that facepieces, even for positive pressure units, be fit tested in the negative pressure mode. The respirator user should have the option to try different sizes of face pieces (for example: small, medium, & large) while undergoing initial and subsequent fit testing. The manufacturer can provide assistance by providing an adapter to test the SCBA facepiece in the negative pressure mode.

A user seal check is a method for determining whether a respirator has been properly donned (put-on) and properly adjusted to ensure a proper fit. Respirator users should perform a user seal check every time the respirator is donned, before entering a contaminated area, any time the user detects a seal breakage due to work rate and any time the respirator is doffed and re-donned due to hydration or rest cycles. A user seal check evaluates the quality of the seal of the respirator by having the user put the facepiece under positive or negative pressure and noticing leakage. User seal check procedures are located in Appendix B-1 of the OSHA Respiratory Protection Standard [29 CFR 1910.134]. Manufacturer's user seal check procedures, which are located in the manufacturer's user's instructions specific to the model of respirator, are also available and provide unique product insight to the workings of the respirator.

10. What type of training do I need to ensure that I can properly use a NIOSH approved CBRN SCBA respirator?

- The respirator program administrator is responsible for establishing a training program in compliance with the OSHA Respiratory Protection Standard [29 CFR 1910.134]. Employees should be trained on the following aspects:

- Why the respirator is necessary and how improper fit, usage, or maintenance can compromise the protection of the respirator;
- What the limitations and capabilities of the respirator are;
- How to use the respirator effectively in emergency situations, including situations in which the respirator malfunctions;
- How to inspect, put on and remove, use, and check the seals of the respirator;
- How to recognize medical signs and symptoms that may limit or prevent the effective use of respirators
- Unique CBRN SCBA user's instructions and locations of CBRN NIOSH label confirming CBRN approval of the CBRN SCBA or upgraded SCBA to CBRN protection.

11. Is it necessary to wear a protective suit ensemble or protective clothing in conjunction with a CBRN SCBA?

Some CBRN contaminants produce toxic effects by contact with the skin. These effects can be immediate or delayed depending on the type of contaminant. NIOSH has issued Caution and Limitation 'Q' for the CBRN SCBA stating:

"Q Use in conjunction with personal protective ensembles that provide appropriate levels of protection against dermal hazards."

Although CBRN SCBA are approved by NIOSH as stand alone respiratory protection devices and not in tandem with a protective suit ensemble or other type of protective clothing, this statement advises users that an appropriate level of protective clothing should be worn with the CBRN SCBA based on the need for dermal protection against CBRN hazards.

CBRN SCBA are designed by manufacturers to be compatible with various levels of protective clothing, including encapsulating suits (those which completely enclose the wearer's entire SCBA) and non-encapsulating protective suits (suits which partially enclose or cover the SCBA). The type of protective clothing or protective suit ensemble must be based on dermal protection needed for the identified type of CBRN hazard. The user must be outfitted with an appropriate protective ensemble or protective suit to protect against skin absorption. The selection of the protective ensembles must relate to recognized definitions of the types of ensembles that can be used for CBRN incidents. It is not the intention to use the certified CBRN SCBA for multiple incidents, however; it may be possible to reenter specific CBRN incidents following a quick gross decontamination and clean replenishment of air supply. If the protective suit is compromised and a non-CBRN approved SCBA is worn instead of a CBRN approved SCBA, the interior of the suit becomes a confined space allowing for agent to attack the dermal areas and respiratory system. The predominate route of entry for chemical warfare agents is the respiratory system. Adequate protection provided by a NIOSH approved CBRN SCBA will ensure minimum respiratory protection is provided even if the suit is compromised. This protective quality may offer just enough time for the wearer to escape contamination and go to a less contaminated area for immediate decontamination. A properly maintained and donned NIOSH CBRN SCBA provides the highest level of respiratory protection available to Level A or Level B outfitted responders.

12. Will wearing a protective suit ensemble protect my CBRN SCBA from becoming contaminated?

Only protective clothing ensembles designed to completely enclose an SCBA within an encapsulating suit, those which completely enclose the wearer's entire SCBA, or non-encapsulating suit, suits which enclose but are not vapor tight, will provide a level of protection for the SCBA hardware to prevent or reduce exposure of the SCBA to contamination. Protective clothing ensembles that expose the CBRN SCBA visor and second stage regulator to ambient toxic concentrations should be limited to vapor exposures if possible. It is expected that CBRN liquid agents will attack any open crevice between the respirator facepiece and the protective ensemble hood or collar. If known CBRN liquid exposures are expected or determined, emergency responders should require full Level A encapsulated ensembles to protect the entire responder and SCBA. The next generation of improved Level A ensembles or variations of that ensemble are incorporating unique respirators with suit interfaces that bridge the gap that chemical tape (Chem Tape) covers? NFPA compliance standards designed to test ensembles do not allow the use of chemical tape (specific adhesive tape that is designed by manufacturers to be chemically resistant to CBRN agents when applied correctly).

EPA developed Level A and B personal protection utilizes SCBA and specific protective suit ensembles with accessories. EPA Level A suit ensembles are vapor, aerosol, solid, liquid, and gaseous protective against known specific industrial agents. NIOSH CBRN approvals do not exist for EPA Level A, B, C or D protective suit ensembles. NFPA compliance testing of given protective ensembles is underway and expected to provide

a level of CBRN protection under a given laboratory condition. EPA Level B suit ensembles are liquid-tight and provide protection from liquid splashes but do not protect against chemical vapors or gases. NIOSH recognizes that the protection provided by a Level A or Level B encapsulated suit will likely prevent CBRN contamination from contacting a NIOSH CBRN SCBA depending on the physical state of the CWA (liquid or gas/vapor state) and the corresponding Level A or B suit, but currently does not issue approvals to that effect. In these instances where the appropriate level of encapsulated suit is used corresponding to the physical state of the CWA, the limitation of 6 continuous hours of use from the time of initial chemical warfare agent (CWA) exposure would not apply until the suit is compromised or the CBRN SCBA is inadvertently or deliberately exposed to CWA contamination as a result of doffing, normal wear and tear or direct or collateral physical or puncture damage.

For Level B ensembles which are non-encapsulating, the CBRN SCBA head harness must be on the inside of the ensemble and not be directly exposed to ambient hazards. If the head harness is worn over the protective hood, the fit test sealing properties will most likely not be replicated or the facepiece will have to be tightened excessively to obtain a proper seal. While this process may seam to bridge the suit to respirator interface gap, it does not allow the suit to fully protect the head area and may compromise the sealing properties of the respirator facepiece. Those SCBA components exposed to the environment, such as the lens of the facepiece, should be considered contaminated if used in a CWA agent environment, and for those components, the 6 hour use limitation will apply.

In the case of protection against chemical warfare agents, not all chemical protective suits are tested and provide the same level of protection against chemical warfare agents. A suit ensemble which has been tested to a proven protection standard against CWA or CWA qualified simulants must be used if CWA protection is required.

13. How do I determine that my 'Non-CBRN' NIOSH-approved SCBA can be upgraded to NIOSH-approved CBRN protection?

Please contact the respirator manufacturer first. Concurrently or subsequently, visit the NIOSH NPPTL website to locate the model of SCBA in use and whether it has a NIOSH approved CBRN Upgrade/Retrofit Kit available. Select models of previously deployed traditional 'non-CBRN' NIOSH approved SCBA can be upgraded for protection against CBRN agents using procedures and materials designated by NIOSH. The best source of help for this question is to contact the respirator manufacturer of the currently deployed traditional industrial unit to determine if it is capable of being upgraded. A manufacturer's representative may need to physically inspect the unit to determine if it is a model that is capable of being upgraded to CBRN protection status. Only NFPA 1981, editions 1997 and 2002, have NIOSH approved CBRN SCBA upgrade kits approved and in production.

The CBRN SCBA upgrade procedure involves accurate configuration management, identification of field deployed SCBA that are eligible for upgrade, installation of specific new parts, inspection, testing, re-installation of defective components found during inspection, and adding new CBRN Retrofit labels and instructions. This CBRN SCBA upgrade approval signifies that the products receiving the upgrade are expected to protect firefighters and other emergency responders from CBRN-related gaseous, airborne particulate, and liquid respiratory exposures. NIOSH based its determination on positive results from rigorous laboratory tests, evaluation of product specifications for the upgrade procedures, materials, and an assessment of the manufacturer's quality control procedures. A bill of materials identifying the various models of SCBA eligible for CBRN SCBA upgrades is available from the manufacturer. CBRN SCBA upgrade of a SCBA

should not be done by untrained or unauthorized personnel. Contact the SCBA manufacturer for specific CBRN SCBA upgrade programs available.

Digital image to be inserted

Figure XX, Field Deployed SCBA with CBRN SCBA Upgrade Kit Complete, 2003, Courtesy NIOSH and MSA. Notice the "CBRN" letters on the second stage regulator.

APPENDIX E

Sample NIOSH Approval Label

The following items are integral to configuration management of NIOSH CBRN SCBA. They are the NIOSH Approval Letter, the NIOSH approved parts list, known as an 'assembly matrix', the NIOSH exploded view drawing, the NIOSH test results, the NIOSH adhesive labels on the harness assembly, and the "CBRN Agent Approved" adhesive approval labels and if applicable, the adhesive CBRN Agent Approved (Retrofit) approval label. The following example is an of an actual CBRN SCBA approval label paper insert that is required to be in the user's instructions of the CBRN SCBA.

Digital image to be inserted

APPENDIX F

User Guidance Checklist

1. Are CBRN SCBA available for all first responders and first-arriving departments?
2. If CBRN SCBA are available do they carry the NIOSH CBRN Agent Approved or Retrofit labels?
3. If CBRN SCBA are not available, have the available SCBA been tested by a third party for determination of resistance to liquid or vapor chemical warfare agent?
4. Are CBRN SCBA available from mutual aid departments?
5. Do actual responders have basic and advanced WMD awareness training prior to entering an unknown situation with SCBA or CBRN SCBA?
6. Are the drivers of incoming responder vehicles trained to drive with CBRN SCBA donned?
7. Are cabins of incoming responder vehicles over-pressurized to maintain a level of protection to passengers in or out of CBRN SCBA?
8. If you have just purchased new or upgraded CBRN SCBA, do you have complete confidence that all unique CBRN protection characteristics of the SCBA have been explained and understood?
9. Are emergency and deliberate entry SOPs updated to include the use of CBRN SCBA?
10. Are provisions in place to supply CBRN approved respirators to initial and triaged casualties?
11. Are available Level A protective ensemble pass thru devices compatible with CBRN SCBA?
12. Does local SOP or SOG emphasizes proper respirator fit testing, head harness worn over head instead of outside on hood of ensemble/suit, and CBRN SCBA use life (CRUL)?
13. Who is the CBRN SCBA hydrostatic tester?
14. Is the CBRN SCBA fully assembled?
15. Is the CBRN SCBA fully operational?
16. Does the CBRN SCBA show the correct NIOSH CBRN label confirming the system is CBRN approved?
17. Do the part numbers listed on the NIOSH CBRN label insert located in the user's instructions, match the part numbers visible on the CBRN SCBA?
18. Are all manufacturer unique CBRN markings readily known by the wearer?
19. Are all readiness before use operations checks complete?
20. Are CBRN SCBA decontamination plans in place?
21. Are CBRN SCBA disposal plans in place?
22. Are CBRN SCBA replacement parts and systems in place?
23. Are CBRN SCBA air compressed cylinders full and in ample supply for cylinder change out in a clean staging area? Are universal cylinders in use?
24. Is an established CBRN SCBA use life protocol available and capable of being implemented?
25. Are compatible protective ensembles available to provide dermal protection?
26. Are proper handling techniques established and rehearsed for handling contaminated CBRN SCBA after each use or between multiple entries during the same use?
27. Are decontamination and disposal procedures followed as required? Are manufacturers consulted on recommended decontamination procedures?
28. If liquid CBRN agents contaminate the CBRN SCBA, are disposal actions in place to discard the CBRN SCBA after decontamination actions are complete?
29. Is the respirator used beyond 6-hours after initial exposure to chemical warfare agents? If so, confirm that contamination is not present. If contamination is present, ensure CBRN SCBA is not used beyond six

hours after initial exposure to chemical warfare agents to avoid possibility of agent permeation into SCBA materials or breathing zone.

30. Is a CBRN SCBA upgrade kit in use? If so, is it fully functional and compatible?

APPENDIX G

CBRN SCBA Training Aid Pamphlet

The training aid pamphlet is available as a separate 8.5 x 5.5 inch cargo-pocket publication. The following information is a verbiage extract of the training aid pamphlet. Use the ordering information. (For purposes of external review, please read the separate electronic adobe pdf file that contains the most current version of the training aid. The below information is a placeholder.)

NIOSH-Approved CBRN SCBA User's Guide

Training Aid

July 29, 2005

DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTERS FOR DISEASE CONTROL AND PREVENTION
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

Draft. Do Not Cite or Quote.

Ordering information

To receive documents or more information about occupational safety and health topics, contact the National Institute for Occupational Safety and Health (NIOSH) at

NIOSH Publications Dissemination
4676 Columbia Parkway
Cincinnati, OH 45226-1998
Telephone: 1-800-35-NIOSH (1-800-356-4674)
Fax: 513-533-8573
E-mail: pubstaft@cdc.gov
or visit the NIOSH Web site at www.cdc.gov/niosh

Disclaimer

DHHS (NIOSH) Publication No. 2005-XXX

Foreword

This training aid is an educational tool created to enhance the safety and health of responders using self-contained breathing apparatus respirators (SCBA) approved with chemical, biological, radiological, and nuclear (CBRN) protection by the National Institute for Occupational Safety and Health (NIOSH). NIOSH-approved CBRN SCBA protect emergency responders against hazards associated with CBRN terrorism and significantly enhance the nation's overall defense strategy.

This training aid is a companion document to the comprehensive *NIOSH CBRN SCBA User's Guide** and summarizes key topics which are more fully explained in detail in that publication. This training aid should not be viewed as a complete CBRN SCBA training guide, but rather as a reference tool for individuals who have received training from the *NIOSH CBRN SCBA Guide*. Both publications should serve as complements to, not substitutes for, a required respiratory protection program.

The purpose of the *NIOSH CBRN SCBA User's Guide* is to educate individual respirator wearers, incident commanders, and team leaders, about the selection, operation, protections, and cautions and limitations of CBRN SCBA approved by NIOSH.

A list of NIOSH-approved CBRN SCBA is available on the NIOSH website at:
http://www.cdc.gov/niosh/npptl/topics/respirators/cbrnapproved/scba/.

For more information about NIOSH-approved respirators and respirator use guidelines call 1-800-35-NIOSH.

Director, National Institute for Occupational Safety and Health
Centers for Disease Control and Prevention

** NIOSH Recommended Guidelines for the Use of Chemical, Biological, Radiological, Nuclear (CBRN), Open Circuit, Pressure Demand, Self-Contained Breathing Apparatus (SCBA) Respirators Certified Under 42 CFR Part 84* DHHS Publication No. ———

Acknowledgements

Terrence K. Cloonan of NIOSH and Michael Bergman of EG&G Technical Services, Inc. are the document authors.

NIOSH expresses gratitude to Heinz Ahlers and Judi Coyne for their technical review comments and managerial guidance.

A special thanks to Candace Wolf and Donna Budniewski of Sci-Tek

Environmental Services, Inc., and Amanda Ford of EG&G Technical Services, Inc. for editorial and graphics support.

Table of Contents

Page
Foreword iii
Acknowledgments iv
Step 1) CBRN Agent Approved Label 1
Step 2) Required Compliance Labels 2
Step 3) NIOSH Cautions and Limitations You Need to Know 3
Step 4) CBRN Respirator Use Life (CRUL) 5
Step 5) User's Instructions (UI) 6
Step 6) Facepiece Indications of Concern 7
Step 7) Decontamination 8

Figure 1. Law enforcement emergency response team (ERT), circa 2000. Courtesy of Scott Health and Safety.

Step 1 *Verify that the CDC NIOSH CBRN Agent Approved adhesive label is on the SCBA backframe! If the label is scratched or unreadable, confirmation of CBRN protection should be made with the manufacturer or NIOSH.*

This same style of label may say "Retrofit" if the SCBA was a previously deployed industrial SCBA which was later upgraded to CBRN.

Figure 3. Example of a CDC NIOSH CBRN agent approved retrofit adhesive label.
Figure 2. Example of a CDC NIOSH CBRN agent approved adhesive label.

Step 2 *Verify that your CBRN SCBA is assembled only with the parts listed in the NIOSH matrix-style approval label included with the user instructions.*

Figure 4. Example of a NIOSH CBRN SCBA matrix-style approval label.
Figure 5. Actual back frame assembly with affixed CDC NIOSH CBRN agent approved label, NIOSH abbreviated harness label and SEI compliance label. All three labels are required for NIOSH CBRN SCBA certification.

1. PROTECTION
SC Self-contained
PD Pressure-demand
CBRN Chemical, biological, radiological and nuclear

2. CAUTIONS AND LIMITATIONS
I Contains electrical parts which have not been evaluated as

an ignition source in flammable or explosive atmosphere by MSHA/NIOSH.
J Failure to properly use and maintain this product could result in injury or death.
M All approved respirators shall be selected, fitted, used, and maintained in accordance with MSHA, OSHA, and other applicable regulations.
N Never substitute, modify, add, or omit parts. Use only exact replacement parts in the configuration specified by the manufacturer.
O Refer to user's instructions, and/or maintenance manuals for information on use and maintenance of these respirators.
S Special or critical user's instructions and/or specific use limitations apply. Refer to user's instructions before donning.

3. CAUTIONS AND LIMITATIONS: CBRN
Q Use in conjunction with personal protective ensembles that provide appropriate levels of protection against dermal hazards.
R Some CBRN agents may not present immediate effects from exposure, but can result in delayed impairment, illness, or death.
T Direct contact with CBRN agents requires proper handling of the SCBA after each use and between multiple entries during the same use. Decontamination and disposal procedures must be followed. If contaminated with liquid chemical warfare agents, dispose of the SCBA after decontamination.
U The respirator should not be used beyond 6 hours after initial exposure to chemical warfare agents to avoid possibility of agent permeation.

Step 3 *NIOSH Cautions and Limitations You Need to Know*

INDUSTRIAL USE

The following NIOSH cautions and limitations appear in Section 2 of the CBRN SCBA matrix-style approval label and apply to industrial use:

I Contains electrical parts, which have not been evaluated as an ignition source in flammable or explosive atmospheres by MSHA/NIOSH.
J Failure to properly use and maintain this product could result in injury or death.
M All approved respirators shall be selected, fitted, used, and maintained in accordance with MSHA, OSHA, and other applicable regulations.
N Never substitute, modify, add, or omit parts. Use only exact replacement parts in the configuration as specified by the manufacturer.
O Refer to user's instructions, and/or maintenance manuals for information on use and maintenance of these respirators.
S Special or critical user's instructions and/or specific limitations apply. Refer to user's instructions before donning.

Note:
The caution and limitation 'S' will only be on the NIOSH CBRN approval label if specified by the manufacturer in the user instructions. When 'S' appears on the NIOSH approval label, the corresponding Cautions and Limitations that apply under 'S' will be explained in a designated section of the manufacturer's user instructions (UI).
Caution and limitation 'I' will not be present on units which have met the

evaluation requirements by MSHA/NIOSH for the criteria stated in 'I'.

CBRN Use

The following NIOSH cautions and limitations appear in Section 3 of the CBRN SCBA matrix-style approval label and, along with the industrial use limitations, apply specifically to use in CBRN environments.
Q Use in conjunction with personal protective ensembles that provide appropriate levels of protection against dermal hazards.
R Some CBRN agents may not present immediate effects from exposure, but can result in delayed impairment, illness, or death.
T Direct contact with CBRN agents require proper handling of the SCBA after each use and between multiple entries during the same use. Decontamination and disposal procedures must be followed. If contaminated with liquid chemical warfare agents, dispose of the SCBA after decontamination.
U The respirator should not be used beyond six hours after initial exposure to chemical warfare agents to avoid possibility of agent permeation.

Step 4 CBRN Respirator Use Life (CRUL)

When a CBRN SCBA is contaminated with a chemical warfare agent (CWA) in vapor, aerosol, or liquid form, it has a limited use life of ***six continuous hours***, beginning at the time of an exposure. The time of CWA exposure is determined by using qualitative or quantitative detection methods in the field, or by laboratory analysis of SCBA removed from the site.
Remember:
• The time period is ***six continuous hours***, not a sum of smaller time periods of intermittent use
• At the six-hour mark, the entire SCBA must be decontaminated and disposed of properly
• The SCBA cannot be reused following the six-hour period
• CWA are nerve and blister agents
– **Nerve agents** include: GA (Tabun), GB (Sarin), GD (Soman), GF (cyclohexyl Sarin), and V-series agents, such as VX
– **Blister agents** include: H (sulfur mustard), HD (distilled sulfur mustard), nitrogen mustard (HN-1, HN-2 and HN-3) and Lewisite (L, L-1, L-2 and L-3)

Step 5 User's Instructions (UI)

The User's Instructions (UI) are included with every purchase of a new CBRN SCBA and typically include guidance on:

- Checks for unique parts labeled "CBRN" by the manufacturer
- Pre-use and in-use checks
- Donning and doffing
- Fit-testing and user seal checks
- Unit assembly
- Air cylinder inspection
- Cautions and warning statements unique to each respirator model
- Inspection checklists
- How to verify that the hydrostatic test date on the cylinder is current
- Regulator function (both first stage and second stage regulators)
- Function of all end-of-service-time-indicators (EOSTIs)
- Function of heads up display (HUD)
- Integrity of hoses for damage and tight hose connections
- Function of personal alert safety systems (PASS) if present

Step 6 Facepiece Indications of Concern

You may have donned the SCBA facepiece incorrectly if:
A) The inside of the facepiece is fogged over
Corrections
- Use anti-fog solution
- Redon the facepiece
- Check that the air is fully turned on
- Seek training or re-training on use of HUD
- Low pressure in cylinder -- seek recharge

B) The second stage regulator or air-hatch will not operate correctly or mate properly with the facepiece

Corrections – In a clean atmosphere:

- Disconnect and reconnect the regulator per manufacturer's instructions or manually open and close the air hatch per manufacturer's instructions.
- Ensure facepiece matches make and model of regulator/SCBA
  Ensure locking mechanisms are fully seated and not broken
- Ensure debris is not in the facepiece port or regulator connection ports

C) Heads up display (HUD) is not working

Corrections
- Inspect the HUD for damage
- Ensure the batteries are serviceable
- Reconnect the second stage regulator to the facepiece to ensure that it is correctly attached
- Ensure the electronic connections of the HUD are clean

(if applicable)

Step 7 Decontamination

Have a plan for the decontamination (decon) and disposal of contaminated CBRN SCBA. The six-hour continuous use life concept includes the decontamination process, but not the disposal of CBRN SCBA following use in a chemical warfare agent (CWA) environment. CWA are nerve agents and blister agents (See Step 4). If known or suspected contamination is present on the CBRN SCBA, quickly conduct gross decontamination using all available systems such as ladder truck decon or other field expedient decon operation using high volume, low pressure clean water, to remove surface CBRN agent contamination. Contain and properly dispose of contaminated run-off wash. Certain CBRN agents will not be neutralized while others will be hydrolyzed or diluted while being physically washed off equipment surfaces using these techniques. Contamination avoidance, mitigation, and decontamination practices should be planned out and trained for in advance. Confirmed contaminated SCBA must be discarded in accordance with local regulatory HAZWOPER operations. If time permits, users should ensure that known or potentially contaminated CBRN SCBA are triple bagged in plastic, labeled with the type of contamination, the amount/type of decontamination solution used, and the technique used to conduct gross decontamination. The amount of exposure time for contaminated SCBA and the amount of CBRN contamination are also beneficial information relative to disposal. Local and state disposal procedures for specific CBRN agent contamination should be followed. A decontamination method specific to the type of CBRN contamination present may contribute to the efficacy of decontamination operations. Seek decontamination guidance from the local incident commander or lead federal agency onsite. Detection of CBRN agents on SCBA is situational dependent and subject to qualified quantitative methodology review by the lead federal agency.

Notes

Draft Draft

NPPTL

Delivering on the Nation's Promise:

Safety and health at work for all people

Through research and prevention

For information about NIOSH:
1-800-35-NIOSH (1-800-356-4674)
Fax: 513-533-8573
E-mail: pubstaft@cdc.gov
www.cdc.gov/niosh

DISCLAIMER

DHHS NIOSH Publication No. XXXX-XXX

APPENDIX H:

References Cited and Bibliography

NIOSH Pub [2000]. Dower, JM, Metzler, RW, Palya, FM, Peterson, JA, Pickett-Harner, M.

NIOSH-DOD-OSHA Sponsored, Chemical and Biological Respiratory Protection Workshop Report. Cincinnati, OH: U.S Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health. DHHS (NIOSH) Publication No. 2000-122.

CFR [1995]. 42 CFR 84 (1995). Code of Federal Regulations. Washington, DC: U.S. Government Printing Office, Office of the Federal Register.

CFR [1999]. 40 CFR 68.130 (1999), Code of Federal Regulations. Table 1, List of Regulated Toxic Substances and Threshold Quantities for Accidental Release Prevention. Washington, DC: U.S. Government Printing Office, Office of the Federal Register.

ATSDR [1999]. 1999 CERCLA Priority List of Hazardous Substances That Will Be the Subject of Toxicological Profiles & Support Document. U.S. Department of Health and Human Services, Division of Toxicological, Agency for Toxic Substance and Disease Registry (ATSDR).

NIOSH RSL [2004]. NIOSH Respirator Selection Logic. U.S. Department of Health and Human Services (DHHS), Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health.

NIOSH Pub [2004]. Jackson B, Baker J, Ridgely M, Bartis J, Linn H. Protecting Emergency Responders, Volume 3, Safety Management in Disaster and Terrorism Response. Cincinnati, OH: U.S Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2004-144.

RAND [2002]. Protecting Emergency Responders, Lessons Learned from Terrorist Attacks. RAND Conference Proceedings, CF-176-OSTP, 2002.

Revoir and Bien [1997]. Revoir W, Ching-Tsen Bien, Respiratory Protection Handbook, CRC Lewis Publishers: Boca Raton, New York, 1997.

FDNY TngB [1991]. Scott 4.5 Positive Pressure Mask Self-Contained Breathing Apparatus (SCBA). Training Bulletin Mask, Fire Department, City of New York, DCN: 4.03.04.

FDNY Add 1-220 [1995]. SCBA Policy, All Unit Circular 220, Addendum 1, Fire Department, City of New York, DCN: 4.03.04.

FDNY 329 [2000]. FDNY Policy/OSHA Respiratory Standards, All Unit Circular 329, Fire Department, City of New York.

FDNY 220 [1997]. Self-Contained Breathing Apparatus (SCBA) Policy, All Unit Circular 220, Fire Department, City of New York, 1997 Mar 15; DCN: 4.03.04.

NIOSH Letter [2001]. NIOSH letter to all respirator manufacturers. Acceptance of Applications for the Testing and Evaluation of Self-Contained Breathing Apparatus for Use Against Chemical, Biological, Radiological and Nuclear Agents.

NIOSH Letter [2002]. NIOSH letter to all manufacturers of SCBA, Continuance of Flexible CBRN SCBA Program.

NIOSH Letter [2003]. NIOSH letter to all manufacturers. Upgrade of Previously–Deployed SCBA Configurations to CBRN Approval Status.

http://library.thinkquest.org/27393/dreamvr/agents/sarin2.htm, May 19, 2004.

NIOSH Pub [2002]. Interim Recommendations for Firefighters and Other First Responders for the Selection and Use of Protective Clothing and Respirators Against Biological Agents. Cincinnati, OH: U.S Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2002–109.

MIIS [2001]. Chronology of Aum Shinrikyo's CBW Activities. Monterey Institute of International Studies 2001.

NFPA 1981 [2002]. National Fire Protection Association Standard: Open-Circuit Self-Contained Breathing Apparatus for Fire and Emergency Services, 2002 Edition.

Fire/Rescue Guide [2000]. LeSage, P, EMT-P, Battalion Chief. Fire and Rescue Field Guide, A Pocket Reference for Firefighters & Command Officers.

EMS Guide [1992]. Tardiff J, Derr P, LeSage P. EMS Field Guide, Basic and Intermediate Version, A Pocket Reference for Basic and Intermediate Providers, 2d edition-InforMed.

CBRN UI [2003]. Operations Manuals. Chemical, Biological, Radiological and Nuclear (CBRN) Self-Contained Breathing Apparatus (SCBA), 30/45/60 Minute, CBRN Series and Industrial Series Operations Manual. Survivair, MSA, Scott, Draeger, ISI, Interspiro, Sabre; 1992–2003.

http://www.med-eng.com/medeng_products_en/medeng_products_product_subgroup_en.js, 9/8/2004.

RDECOM IOP [2004]. US Army RDECOM Protective Equipment Team [2004]. Deconning of Contaminated Material, original revision, IOP No. 12.

NDU-Decon [2004]. Decontamination Workshop Proceedings, CTNSP/NDU Senior Level Seminar Series; Sept 21, 2004, National Defense University, Dwight D. Eisenhower Hall, Washington, DC.

USA Today [2004]. May 18, Sarin Found in Bomb, Likely a Stray Weapon.

9/11 Report [2004]. National Commission on Terrorist Attacks Upon the United States, 2004, *The 9/11 Commission Report, Final Report of the National Commission on Terrorist Attacks Upon the United States,* W.W. Norton & Company Ltd, London.

IAB [2005]. The InterAgency Board 2004 Annual Report & 2005 Standardized Equipment List. Arlington, VA: The InterAgency Board.

NIOSH [2001]. *Suggested Respirator Cleaning and Sanitation Procedures.* Cincinnati, OH: U.S Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health.

NIOSH [2002]. *Protecting Workers from Anthrax Infection.* Cincinnati, OH: U.S Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2002-142.

NIOSH [2002]. *Protecting Workers at the World Trade Center Site.* Cincinnati, OH: U.S Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2002-143.

RDECOM Poster [2004]. Pellar G, Graham, T and Rastogi V., 2004, *Sporicidal Efficacy of Methyl Bromide in Decontamination of a Porous and Non-Porous Surface.* Poster for Bio-Defense Conference, Edgewood Chemical Biological Center, R&T Directorate, US Army.

Sargent [2004]. Sargent, C., *Approach WMD Events with a New Mindset.* Fire Engineering. Penn Well Publishing, Supl.

Ingram [2003]. Ingram, R, *Special Operations and HAZ MAT.* Fire Engineering, Penn Well Publishing, 2003.

http://www.osha.gov/SLTC/emergencypreparedness/cbrnmatrix/index.html
http://www.dhs.gov/dhspublic/interapp/editorial/editorial_0420.xml

CPIC PPT [2004]. *Fallujah Update*, Insurgent Chemical/Explosives Weapons Laboratory, Multi-National Force Iraq, Combined Press Information Center.

Boston FD 53B [2003]. *Decontamination Procedures,* Standard Operating Procedure No. 53B, Boston Fire Department.

Smith [2002]. Smith, James, P., *Strategic and Tactical Considerations on the Fireground*, Brady Fire, 2002, Pearson Education Inc.

Arlington County AAR [2002]. *Arlington County After-Action Report on the Response to the September 11 Terrorist Attack on the Pentagon,* Titan Systems Corporation, DOJ OJP ODP Contract Number GS10F0084K

DOD FM 3-11.9 [2005]. Army, Marine Corps, Navy, Air Force Multi-service Tactics, Techniques, and Procedures, *Potential Military Chemical/Biological Agents and Compounds*, FM 3-11.9, MCRP 3-37.1B, NTRP 3-11.32, AFTTP(I) 3-2.55, US Army Training and Doctrine Command, Fort Monroe, VA.

DOA/ECBC [2004]. U.S. Army, Edgewood Chemical Biological Center (ECBC), *Dispatcher's Guide for WMD Incidents.*

EPA [2005]. Environmental Protection Agency, *Compilation of Available Data on Building Decontamination Alternatives,* EPA Office of Research and Development, National Homeland Security Research Center, Decontamination and Consequence Management Division, Washington, DC.

DOJ [1999]. Department of Justice, Office of Justice Programs, Office for State and Local Domestic Preparedness Support, Participant Manual, *Emergency Response to Terrorism-Law Enforcement Response to Weapons of Mass Destruction Incidents,* Louisiana State University, Academy of Counter-Terrorist Education.

CBRN Terrorism [2004]. Chemical, Biological, Radiological and Nuclear [CBRN] Terrorism, Reporting Guide, Central Intelligence Agency.

CBRN Handbook [2002]. *Chemical, Biological and Radiological Materials Training Handbook,* CTC DCI Counterterrorist Center, Central Intelligence Agency, TSWG International Interagency, First Edition.

PPE Guide [2003]. *Personal Protective Equipment Used with Chemical, Biological and Radiological Materials,* CTC DCI Counterterrorist Center, Central Intelligence Agency, TSWG International Interagency, First Edition.

IFSTA [1998]. *Essential of Fire Fighting,* International Fire Service Training Association, Fire Protection Publications, Oklahoma State University, Fourth Edition.

Preston R [1994]. *The Hot Zone-A Terrifying True Story.* Random House, New York.

McCormick, J, Fisher-Hoch, S, Horvitz, L [1996]. *Level 4-Virus Hunters of the CDC.* Barnes & Noble Books, New York.

United States Coast Guard [2005]. Hazardous Materials Response Special Teams, Capabilities and Contact Handbook, Department of Transportation, United States Coast Guard.